ROCKFORD INSTRUMENT LAB
1718 Broadway
Rockford, IL 61108

INSTRUCTION MANUAL

MODEL 187
4 MHz PULSE/ FUNCTION GENERATOR

WAVETEK
SAN DIEGO

9045 BALBOA AVENUE, SAN DIEGO, CALIFORNIA

INSTRUCTION MANUAL

MODEL 187
4 MHz PULSE/ FUNCTION GENERATOR

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WAVETEK®
SAN DIEGO
9045 Balboa Ave., San Diego, CA 92123
P. O. Box 651, San Diego, Calif. 92112
Tel 714/279-2200 TWX 910-335-2007

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SAFETY

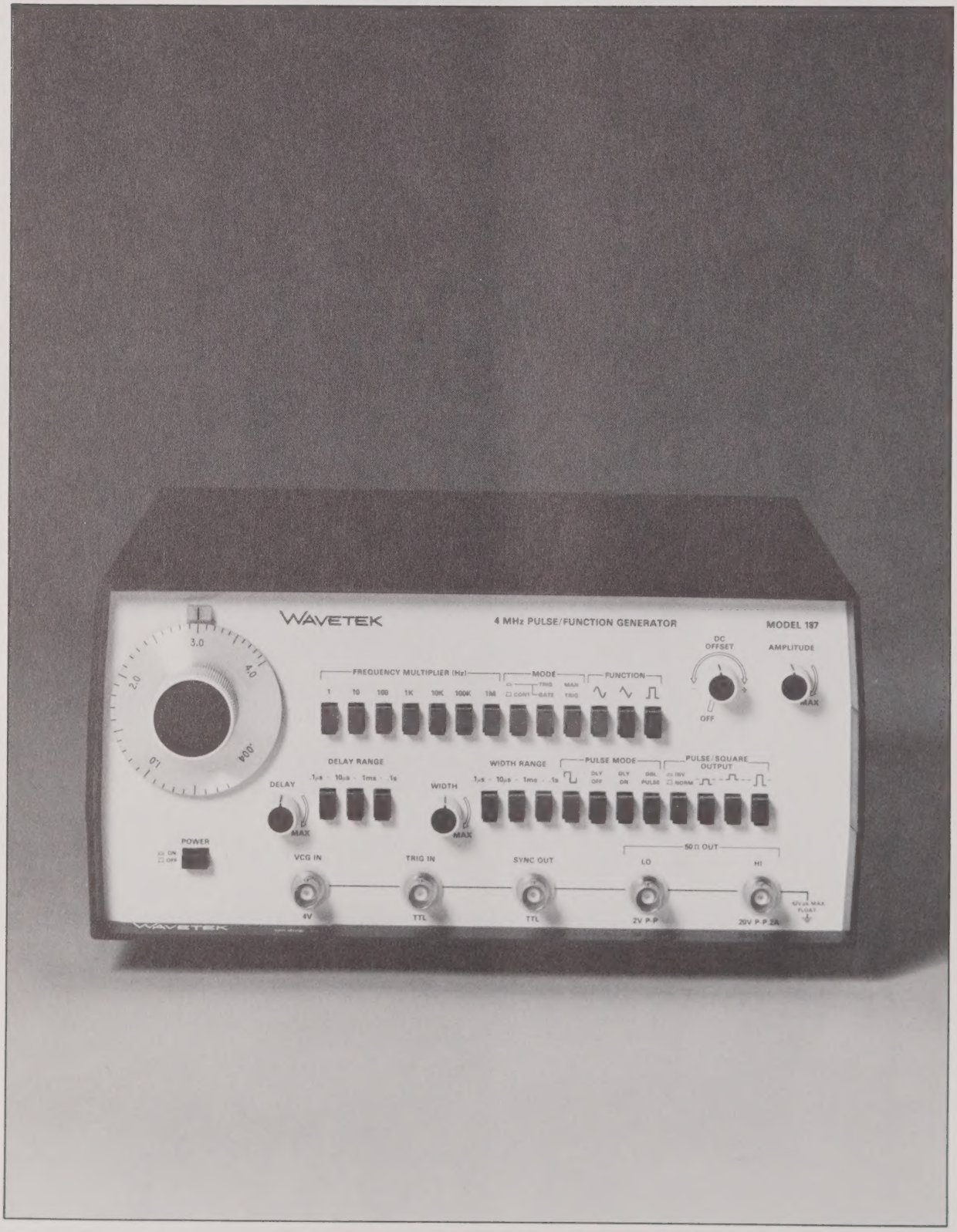
This instrument is wired for earth grounding via the facility power wiring. Do not bypass earth grounding with two wire extension cords, plug adapters, etc.

BEFORE PLUGGING IN the instrument, comply with installation instructions.

MAINTENANCE may require power on with the instrument covers removed. This should be done only by qualified personnel aware of the electrical hazards.

WARNING notes call attention to possible injury or death hazards in subsequent operations.

CAUTION notes call attention to possible equipment damage in subsequent operations.



Model 187 4MHz Pulse/Function Generator

SECTION 1
GENERAL DESCRIPTION

1.1 THE MODEL 187

The Wavetek Model 187, a 4 MHz Pulse/Function Generator, is a precision source of sine, triangle, square and pulse waveforms plus dc voltage. All waveforms are front panel variable from 4 mHz to 4 MHz and can be frequency modulated and swept with an external signal. Variable width and delay, single or double pulses can be output inverted or normal. Amplitude of the waveforms is variable from 10V peak-to-peak into 50Ω down to 30 mV peak-to-peak. DC reference of the waveform can be offset positively or negatively.

The two selectable waveform outputs are a 20V peak-to-peak maximum and a 2V peak-to-peak maximum (20 dB down from 20 Vp-p); both may be varied over a 30 dB range. A TTL level signal at generator frequency is simultaneous with the waveform outputs for synchronization.

1.2 SPECIFICATIONS

1.2.1 Versatility

Instrument operates as either a function generator or pulse generator.

Functions
Sine ∿ ; triangle ∿ ; square ⊓ ; fixed baseline normal pulses ⊓ , ⊓ , ⊓ and inverted pulses ⊔ ⊔ ⊔ and dc.

Operational Modes
Continuous: Generator runs continuously at selected frequency.

Triggered: Generator is quiescent until triggered by external signal or manual trigger, then generates one complete waveform cycle at selected frequency.

Gated: As triggered mode, except output continues for duration of gate signal. Last waveform started is completed.

Frequency Range
0.004 Hz to 4 MHz in 7 overlapping decade ranges:

×1	0.004 to 4 Hz
×10	0.04 to 40 Hz
×100	0.4 to 400 Hz
×1K	4 Hz to 4 kHz
×10K	40 Hz to 40 kHz
×100K	400 Hz to 400 kHz
×1M	4 kHz to 4 MHz

Main Outputs (50Ω OUT)
∿ , ∿ , ⊓ , ⊓ selectable and variable to 20 Vp-p (10 Vp-p into 50Ω) HI output, and to 2 Vp-p (1 Vp-p into 50Ω) LO output. ⊓ , ⊓ , ⊔ , ⊔ selectable and variable from fixed baseline to 10 Vp-p (5 Vp-p into 50Ω) HI output, and to 1 Vp-p (0.5 Vp-p into 50Ω) LO output. Both outputs varied with a 30 dB vernier. Peak output current is 100 mA maximum (HI output). Source impedance is 50Ω.

DC Offset and DC Output
Function baseline offset and dc output selectable and variable through HI and LO BNC outputs. DC only output selected by not selecting a function. HI output is ±10V max (±5V into 50Ω) as offset or Vdc output. Signal-peak plus offset limited to ±10V (±5V into 50Ω). LO output is ±1V max (±0.5V into 50Ω) as is signal-peak plus offset limit. DC offset plus waveform attenuated proportionately at LO (−20 dB) output.

Pulse Modes
Square ⊓ : 50% duty cycle.

Pulse: Adjustable width pulse in phase with sync signal.

Delayed Pulse: Pulse delayed with respect to sync out. Pulse delay and pulse width adjustable.

Double Pulse: Time between pulses and time of pulse width adjustable. Second pulse not generated if delay less than width.

Pulse Period Range
250 ns to 250s in 7 overlapping decade ranges.

Pulse Width
100 ns to 100 ms in 3 ranges with vernier control. Has no effect in ⊓⊔ mode.

Pulse Delay
100 ns to 100 ms in 3 overlapping ranges with vernier control.

Sync Output
TTL pulse (50% ±10% duty cycle at generator frequency. Drives up to 20 TTL loads.

VCG—Voltage Controlled Generator
Up to 1000:1 frequency change with external 0 to ±4V signal. Upper and lower frequencies limited to maximum and minimum of selected range.

Slew Rate: 2% of range per μs.

Linearity: ±0.5% through ×100K range; ±2% on ×1M range.

Input Impedance: 2 kΩ.

Trigger and Gate
Input: TTL compatible levels.

Pulse Width: 50 ns minimum.

Repetition Rate: 4 MHz maximum.

1.2.2 Frequency Precision

Dial Accuracy
±5% of full scale.

Time Symmetry
Duty cycle variation in ⊓⊔ mode, from 0.2 to 4.0 on dial, less than:

±1% to 100 kHz;
±5% to 4 MHz.

1.2.3 Amplitude Precision

Sine variation with frequency less than:

±0.2 dB on all ranges through ×100K, referenced to 1 kHz;
±1.0 dB to 4 MHz.

1.2.4 Function Characteristics

Sine Distortion
Less than:

0.5% on ×1K and ×10K ranges; 1% on ×1, ×10, ×100 and ×100K ranges.
All harmonics 25 dB below fundamental on ×1M range.

Triangle Linearity
Greater than 99% to 200 kHz.

Pulse Rise and Fall Time
At HI output, less than 50 ns for 10 Vp-p output into 50Ω termination.

1.2.5 General

Environmental
Specifications apply at 25°C ±5°C. Instrument will operate from 0°C to 50°C ambient temperatures.

Dimensions
28.6 cm (11¼ in.) wide; 13.3 cm (5¼ in.) high; 26.7 cm (10½ in.) deep.

Weight
3.5 kg (7.7 lb) net; 5 kg (11.2 lb) shipping.

Power
90 to 128V or 180 to 256V, 48 to 66 Hz; less than 30 watts.

NOTE

All specifications apply for dial between 0.2 to 4.0; amplitude at 10 Vp-p from HI output into 50Ω termination.

SECTION 2
INITIAL PREPARATION

2.1 MECHANICAL INSTALLATION

After unpacking the instrument, visually inspect all external parts for possible damage to connectors, surface areas, etc. If damage is discovered, file a claim with the carrier who transported the unit. The shipping container and packing material should be saved in case reshipment is required.

2.2 ELECTRICAL INSTALLATION

2.2.1 Power Connection

WARNING

To preclude injury or death due to shock, the third wire earth ground must be continuous to the facility power outlet. Before connecting to the facility power outlet, examine extension cords, autotransformers, etc., between the instrument and the facility power outlet for a continuous earth ground path. The earth ground path can be identified at the plug on the instrument power cord; of the three terminals, the earth ground terminal is the nonmatching shape, usually cylindrical.

CAUTION

To prevent damage to the instrument, check for proper match of line and instrument voltage and proper fuse type and rating.

NOTE

Unless otherwise specified at the time of purchase, this instrument was shipped from the factory for operation on a 90 to 128 Vac line supply and with a 1/4 amp slow blow fuse. Instruments configured for 180 to 256 Vac have a 1/8 amp slow blow fuse. Select the appropriate fuse and 115 or 230 switch position at the rear panel when changing power sources.

2.2.2 Signal Connections

Use 3 foot RG58U 50Ω shielded cables equipped with female BNC connectors to distribute all input and output signals.

2.3 ELECTRICAL ACCEPTANCE CHECK

This checkout procedure is a general verification of generator operation. Should a malfunction be found, refer to the warranty in the front of this manual.

A two channel oscilloscope, four 3 foot 50Ω coax cables with female BNC connectors, two 50Ω terminations, a coax tee connector and an additional function generator are required for this procedure.

Preset the generator front panel controls as follows:

Control	Position
Dial	2.0
FREQUENCY MULTIPLIER	X 1K
MODE	CONT (released)
FUNCTION	⎍
DC OFFSET	OFF
AMPLITUDE	MAX
DELAY	12 o'clock
DELAY RANGE	10 μs-1 ms
WIDTH	12 o'clock
WIDTH RANGE	10 μs-1 ms
PULSE MODE	⎍
PULSE/SQUARE OUTPUT	NORM ⎍

Set up the oscilloscope, Model 187 and external function generator as shown in figure 2-1 and perform the steps in table 2-1.

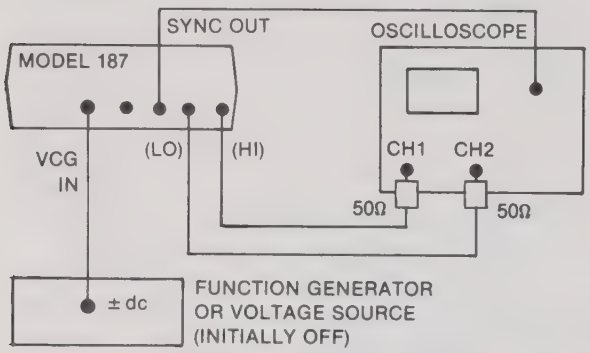


Figure 2-1. First Setup

2.4 CHANGING THE OUTPUT IMPEDANCE

The output impedance is normally:

HI 10V p-p (50Ω source) into 50Ω.
LO 1V p-p (50Ω source) into 50Ω.

Amplitude is normally variable over 30 dB for each output with a 50 dB amplitude range available by utilizing both outputs.

If simultaneous 600Ω and 50Ω output impedances are desired:

1. Change value of R148 from 499Ω to 604Ω.
2. Remove R149.

The result is:

HI 10V p-p (50Ω source) into 50Ω.
LO 10V p-p (600Ω source) into 600Ω.

Amplitude is variable over 30 dB with −30 dB lowest possible amplitude. Square wave rise and fall time is less than 150 ns. Any value greater than 600Ω may also be substituted for the value of R148 for other output impedances.

To increase the range of the variable amplitude control in a modified unit beyond 30 dB, decrease the value of R124 as necessary. Waveform quality relative to the standard unit is not guaranteed below −30 dB and above 20 kHz.

Table 2-1. Initial Checkout

Step	Control	Position/Operation	Observation
1	POWER	ON	±10V square wave on CH1 and ±1V on CH2. Return to CH1 only.
2	Dial	Rotate in both directions. Return to 2.0.	Rotation ccw increases frequency of ⊓⊔ ; rotation cw decreases frequency.
3	FREQUENCY MULTIPLIER	Press each switch sequentially; return to ×1K.	Frequency increases in decade steps, left to right.
4	AMPLITUDE	Rotate ccw.	Amplitude decreases.
5	DC OFFSET	Rotate cw. Return to OFF.	Output immediately offset negative, then moves positive. OFF returns it to original level.
6	AMPLITUDE	Rotate cw.	Square returns to original amplitude.
7	Function Generator or DC Voltage Source	Vary input dc voltage; then disconnect VCG IN input.	Frequency increases with positive voltage and decreases with negative voltage.
8	FUNCTION	Press ∿ and ∿ .	Observe ∿ and ∿ waveforms.
9	MODE	Gate (depress CONT, release TRIG/GATE).	A dc level near zero volts.

Tabie 2-1. Initial Checkout (Continued)

Step	Control	Position/Operation	Observation
10	MANUAL TRIGGER	Press and hold.	Continuous ∿ .
	Set up trigger source as shown in figure 2-2. Set trigger source for 100 Hz TTL signal.		
11	——	———	∿ gated on during positive portion of TTL signal on CH2.
12	MODE	Trigger (depress TRIG/GATE)	One ∿ cycle during positive portion of TTL signal on CH2.
13		Continuous (release CONT)	
14	FUNCTION	Pulse (depress ⊓).	Square wave.
15	PULSE MODE	Depress DLY OFF	
16	WIDTH	Vary, return to 12 0'clock	Pulse width varies.
17	AMPLITUDE	Vary, return to MAX.	Upper and lower levels vary.
18	PULSE/SQUARE OUTPUT	Invert pulse (depress NORM/INV)	Phase inversion of pulse relative to sync signal.
19		Release NORM/INV	
20		Depress ⊓⊓	Positive offset pulse.
21	AMPLITUDE	Vary, return to MAX.	Upper level varies, lower level remains fixed.
22	PULSE/SQUARE OUTPUT	Depress ⊔⊔	Negative offset pulse.

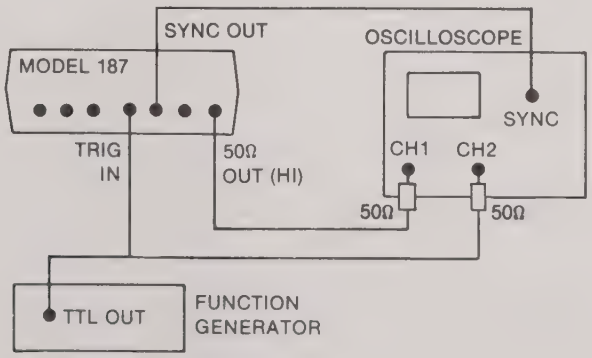


Figure 2-2. Second Setup

Table 2-1. Initial Checkout (Continued)

Step	Control	Position/Operation	Observation
23	AMPLITUDE	Vary, return to MAX.	Lower level varies, upper level remains fixed.
24	PULSE MODE	Depress DLY ON	Pulse position shifts relative to sync signal.
25		Depress DBL PULSE	
26	WIDTH	Decrease (ccw) *NOTE: Pulse width must be less than pulse delay.*	Double pulses displayed.
27	DELAY Vernier	Vary, return to 12 o'clock.	Double pulse separation varies.
28	WIDTH	Vary.	Width of all pulses vary.

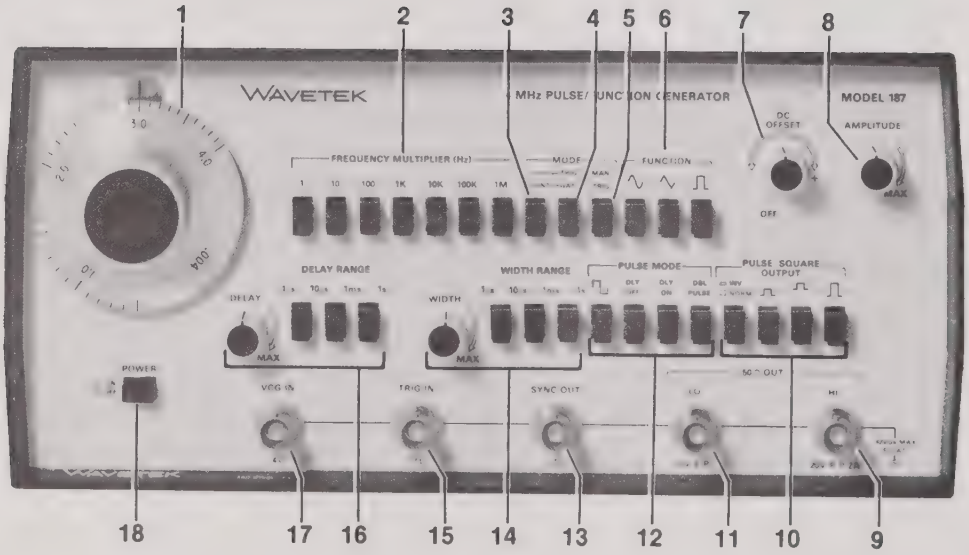


Figure 3-1 Controls and Connectors

SECTION 3
OPERATION

3.1 CONTROLS AND CONNECTORS

The generator front panel controls and connectors are shown in figure 3-1 and keyed to the following descriptions.

1 **Frequency Dial**—Settings under the dial index mark summed with voltage at **17** and multiplied by **2** to determine the output signal frequency.

2 **Frequency Multiplier**—Pushbutton selects one of seven frequency multipliers for **1** and voltage input at **17**.

3,4 **Mode Pushbuttons**—Select one of the following three modes:

Continuous—**3** released, selects continuous output at 50Ω OUT **9** and **11** and SYNC OUT (TTL) **13** connectors.

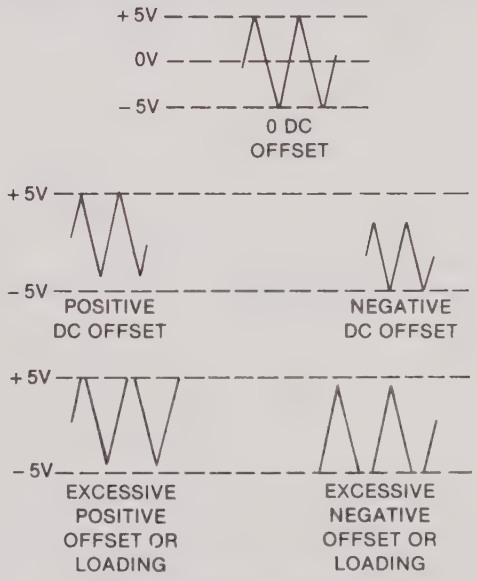
Trigger—**3** and **4** depressed. A dc level output until the generator is triggered by MAN TRIG **5** or with a signal at TRIG IN connector **15**. When triggered, the generator output is one cycle of waveform followed by a dc level.

Gate—**3** depressed and **4** released. Same as trigger except the output is continuous for the duration of the manual or external trigger signal. The last cycle is always completed.

5 **MAN TRIG Pushbutton**—Triggers or gates the output signals when **4** is depressed or released respectively. In the trigger mode, one waveform cycle is output when **5** is pressed. In gate mode, waveform cycles are continuously output as long as **5** is held in.

6 **FUNCTION Pushbuttons**—Select sine ∿ , triangle ∿ or pulse ⎍ waveform. When all three FUNCTION buttons are released the output is a dc level. Pulse waveform parameters are controlled by the second row of controls.

7 **DC OFFSET Knob**—Offsets the 50Ω OUT waveform or gives a dc level (all function switches released) from −10V (ccw, not off) to +10V (cw) (−5V to +5V into 50Ω) at the HI output **9** and from −1V to +1V (−0.5V to +0.5V into 50Ω) at the LO output **14**. An OFF position ensures no dc offset. See figure 3-2.



NOTE: Example is HI output into a 50Ω load.

Figure 3-2. DC OFFSET Control

8 **AMPLITUDE CONTROL**—CCW rotation reduces waveform amplitude at 50Ω OUTPUTS **9** and **11** by 30 dB while CW increases amplitude. DC and offset voltages are not affected by this control.

9 **50Ω OUT HI Connector**—Output for the selected function. Maximum 20 Vp-p (10 Vp-p into 50Ω) with 30 dB continuous amplitude control. 50Ω source impedance. 100 mA peak current for required waveform; 200 mA short circuit current.

10 **PULSE/SQUARE OUTPUT Pushbuttons**—Select the pulse amplitude symmetry relative to the baseline. With DC OFFSET **7** OFF, the baseline is 0V. With DC OFFSET, the baseline is varied by the DC OFFSET control.

—Selects a pulse that maintains amplitude symmetry about the baseline. AMPLITUDE control **8** adjusts the peak-to-peak level of the pulse. See figure 3-3.

—Selects the positive pulse. AMPLITUDE control **8** adjusts the positive peak while the negative peak remains fixed at the baseline. See figure 3-3.

—Selects the negative pulse. Amplitude control **8** adjusts the negative peak while the positive peak remains fixed at the baseline. See figure 3-3.

NORM/INV Pushbutton—Selects normal or inverted pulse output. Inverted pulse is a reversal of the active and inactive levels of the pulse. The net result for a square pulse would be a 180° phase shift with respect to sync pulse. See figure 3-3.

11 **50Ω OUT LO Connector**—Output for the selected function. Maximum 2 Vp-p (1 Vp-p into 50Ω) with 30 dB continuous amplitude control. 50Ω source impedance.

12 **PULSE MODE Pushbuttons**—Select a pulse synchronous with the sync pulse, a pulse delayed with respect to the sync pulse, double pulse (two pulse per pulse period) or a 50% duty cycle pulse.

DBL PULSE Pushbutton—Selects two pulses for each pulse period. In double pulse, DELAY

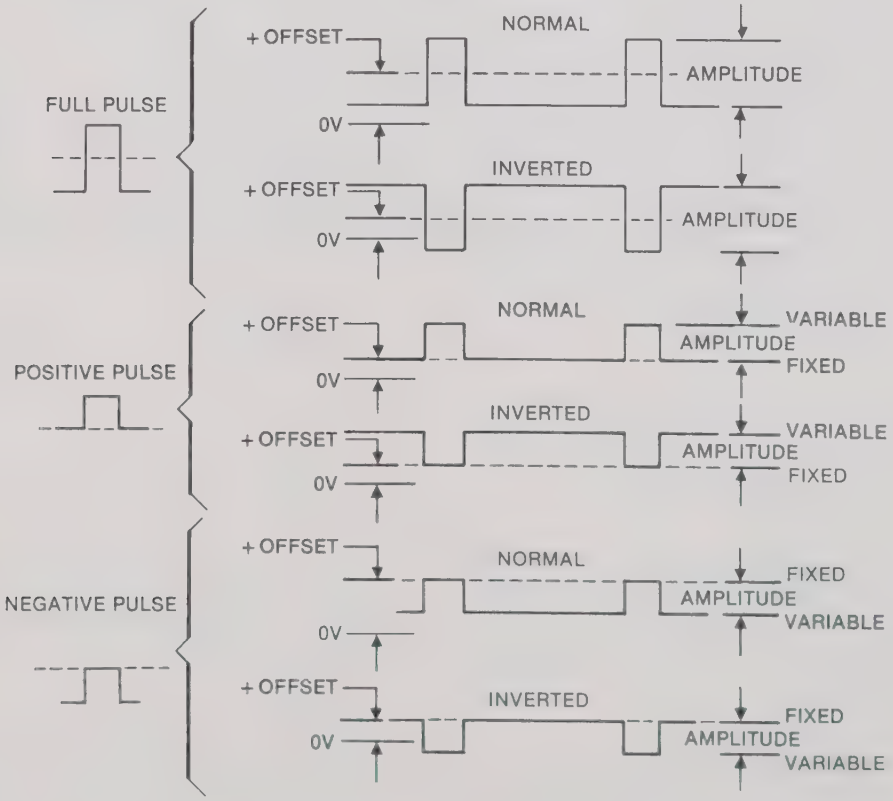


Figure 3-3. PULSE/SQUARE OUTPUT Amplitude/Offset Relationship

RANGE and vernier **16** set the period between the two pulses. WIDTH RANGE and vernier **14** control the pulse width of both pulses. See figure 3-4.

DLY ON Pushbutton—Initiates the DELAY RANGE and vernier **16** to delay the pulse relative to sync output **13.**

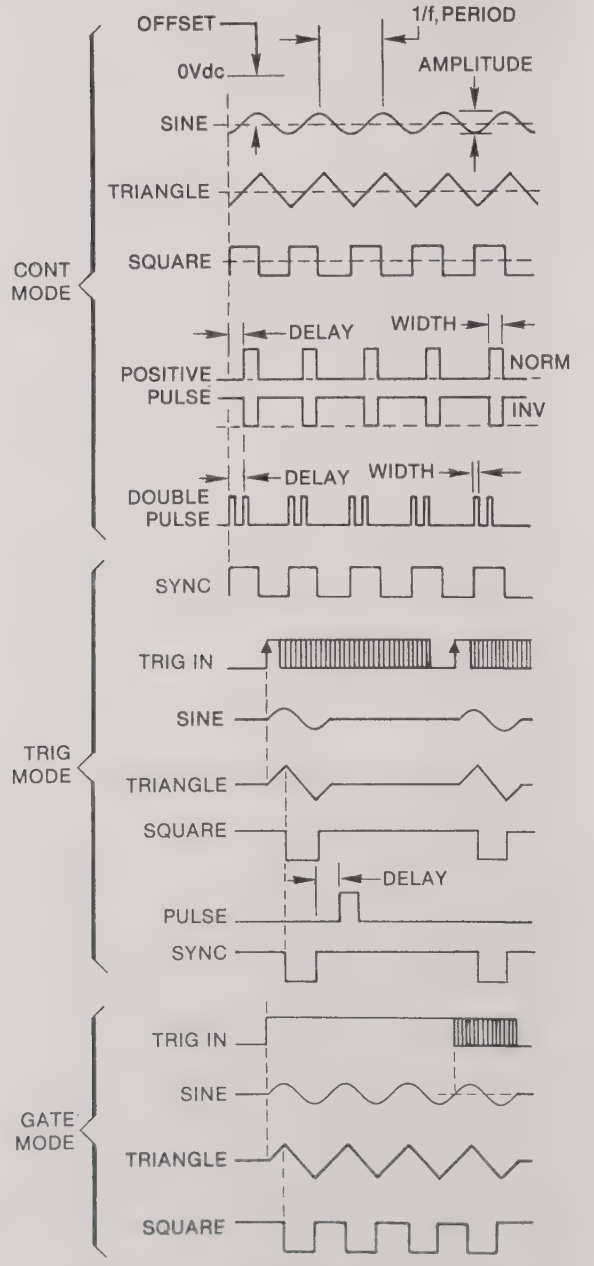


Figure 3-4. Waveform Characteristics

DLY OFF Pushbutton—Inhibits the DELAY RANGE and vernier.

⎍ **Pushbutton**—Selects a square wave. WIDTH RANGE and vernier have no effect on the square wave.

13 **SYNC OUT TTL Connector**—Output for a TTL square wave for each generator cycle. To be used for synchronization or as a TTL signal capable of driving 20 TTL loads. SYNC OUT provides reference for pulse delay.

14 **WIDTH Controls**—Sets pulse width in all pulse modes except ⎍.

WIDTH RANGE Pushbutton—Select one of three pulse width ranges (0.1 μs to 10 μs, 10 μs to 1 ms, 1 ms to 0.1s) for use with WIDTH vernier.

WIDTH Vernier—Varies the width period within the selected WIDTH RANGE. CW increases pulse width, ccw decreases pulse width.

15 **TRIG IN TTL Connector**—Accepts a TTL level signal to trigger or gate the generator. Triggers on the rising (low to high) transition and gates during the positive (high) portion of the trigger signal.

16 **DELAY CONTROLS**—Set pulse delay in delay and double pulse modes.

DELAY RANGE Pushbuttons—Select one of three pulse delay ranges (0.1 μs to 10 μs, 10 μs to 1 ms, 1 ms to 0.1s) for use with the DELAY vernier. Pulse delay is relative to sync output. In double pulse mode, delay controls the period between the two pulses.

DELAY Vernier—Varies the delay period of the selected DELAY RANGE. CW increases pulse delay and ccw decreases pulse delay.

17 **VCG IN Connector**—Accepts ac or dc voltage to proportionately control frequency within the range determined by the FREQUENCY MULTIPLIER **2**. Positive voltage increases the frequency set by the dial **1**; negative voltage decreases the frequency.

18 **POWER Pushbutton**—Applies line power to the generator circuits.

3.2 OPERATION

Perform the initial checkout in Section 2 for the feel of the instrument. Any questions concerning individual controls and connectors may be answered in paragraph 3.1.

3.2.1 Signal Termination

Proper signal termination, or loading, of the generator connectors is necessary for its specified operation. For example, the proper termination of either of the 50Ω OUT connectors is shown in figure 3-5. Placing the 50Ω terminator, or 50Ω resistance, in parallel with a higher impedance, matches the receiving instrument input impedance to the coax characteristic and generator output impedance, thereby minimizing signal reflection or power loss on the line due to impedance mismatch.

The input and output impedances of the generator connectors are:

Connector	Impedance
50Ω OUT (HI)	50Ω
50Ω OUT (LO)	50Ω
SYNC OUT (TTL)	*
TRIG IN	*
VCG IN	2 kΩ

*The TTL OUT connector is diode protected and can drive up to 20 Transistor-Transistor-Logic (TTL) loads (low level between 0V and 0.4V, and high level between 2.4V and 5V). It should not be connected to resistive load less than 600Ω. The TRIG IN connector accepts TTL logic levels, is diode protected, and requires 500 μA drive from a high level output.

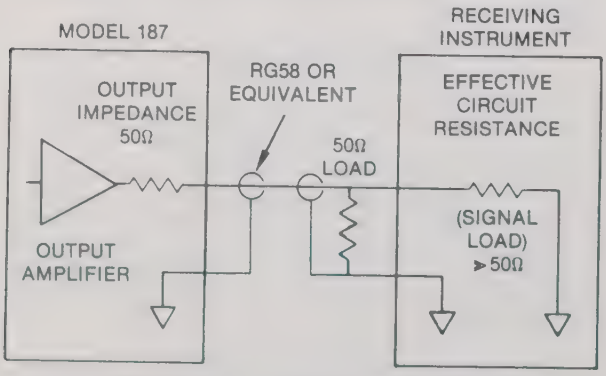


Figure 3-5. Signal Termination

3.2.2 Manual Function Generator Operation

For basic operation, select the waveform frequency and amplitude. The following steps demonstrate manual control of the function generator. (Bold numbers are keys to figure 3-1.)

Step	Control/Connector	Setting
1	50Ω OUT **9, 11**	Connect circuit under test to either output (refer to paragraph 3.2.1)
2	FREQUENCY MULTIPLIER **2**	Set to desired range of frequency.
3	Frequency Dial **1**	Set to desired frequency within the range.
4	FUNCTION **6**	Set to desired waveform. (To select a square wave, depress ⎍ **6**, ⎍ **10** and ⎍ **12**.
5	DC OFFSET **7**	Set as desired. Limited waveform amplitude to prevent clipping (see figure 3-2).
6	AMPLITUDE **8**	Select for desired amplitude.

3.2.3 Voltage Controlled Function Generator Operation

Operation as a voltage controlled function generator (VCG) is as for a manually controlled function generator, only the frequency within particular ranges is additionally controlled by an external voltage (±4V excursions) injected at the VCG IN connector. Perform the steps given in paragraph 3.2.2, only set the frequency dial to determine a reference from which the frequency is to be voltage controlled.

1 For frequency control with positive dc inputs at VCG IN, set the dial for a lower frequency limit.

2 For frequency control with negative dc inputs at VCG IN, set the dial for an upper frequency limit.

3 For modulation with an ac input at VCG IN, set the dial at the desired center frequency. Do not

exceed the maximum range (determined by dial end points and frequency multiplier.)

Figure 3-6 is a nomograph with examples of dial and voltage effects. Example 1 shows that with 0V VCG input, frequency is determined by the main dial setting 2. Example 2 shows that with a positive VCG input, output frequency is increased. Example 3 shows that with a negative VCG input, output frequency is decreased. (Note that the Output Frequency Factor column value must be multiplied by a frequency range multiplier to give the actual output frequency.)

NOTE

Nonlinear operation may result when the VCG input voltage is excessive; that is when the attempted generator frequency exceeds the range limits. The upper limit is four times the multiplier setting, and the lower limit is 1/1000th of the upper limit.

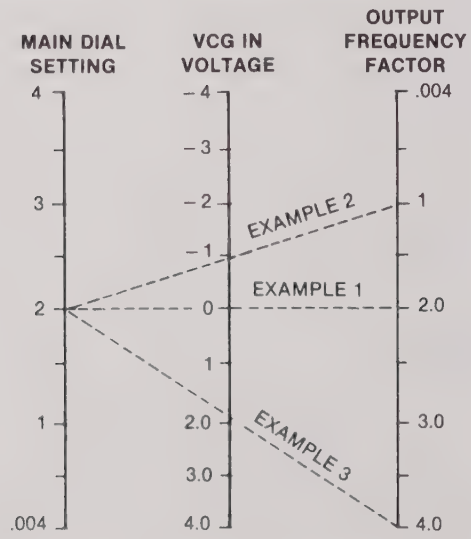


Figure 3-6. VCG Voltage-to-Frequency Nomograph

The up to 1000:1 VCG sweep of the generator frequencies available in each range results from a 4V excursion at the VCG IN connector. With the frequency dial set to 4.0, excursions between −4V and 0V at VCG IN provide the up to 1000:1 frequency sweep. With the dial set to .004, excursions between 0V and +4V at the VCG IN provide up to 1000:1 within the set frequency range.

3.2.4 Pulse Generator Operation

Operation as a pulse generator is similar to the manual and VCG controlled generator except a single pulse, double pulse or square wave may be selected.

The following steps describe the pulse operation setup:

Step	Control/Connector	Setting
1	MODE: CONT **3**	Release CONT.
2	Frequency dial **1**	Select pulse repetition rate.
3	FREQUENCY MULTIPLIER **2**	Select pulse repetition rate.
4	FUNCTION **6**	Depress ⎍ .
5	PULSE/SQUARE OUTPUT **10**	Depress desired pulse output.
6	PULSE MODE **12**	Depress desired pulse mode.
7	WIDTH **14**	Depress desired pulse width range and select desired pulse width. (Not applicable if 50% duty cycle pulse, ⊓⊔ , was selected.)
8	DELAY **16**	Depress desired pulse delay range and select desired pulse delay. (Not applicable if DLY OFF was selected.)
9	DC OFFSET **7**	Set as desired. Limit pulse amplitude as necessary to prevent clipping (see figure 3-2).
10	AMPLITUDE **8**	Select desired amplitude.

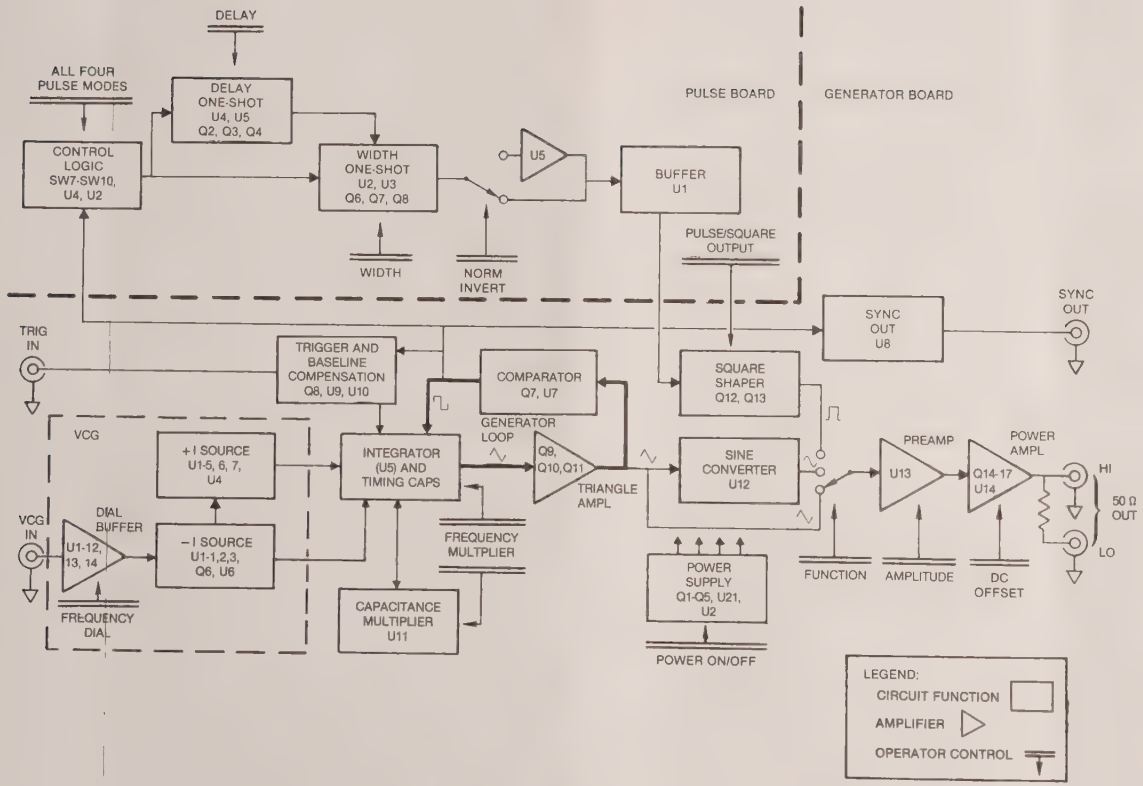


Figure 4-1. Function Block Diagram

SECTION 4
CIRCUIT DESCRIPTION

4.1 INTRODUCTION

This section describes the functions of major circuit elements and their relationships to one another as shown in figure 4-1, functional block diagram.

4.2 GENERATOR BOARD

As shown in figure 4-1, the VCG (Voltage Control of Generator) sums voltage inputs from the frequency dial and the VCG IN connector. This sum voltage controls the magnitude of a complementary current source and current sink. This current varies linearily from approximately 2 mA to 2 μA over a 1000:1 (4.0 to .004) range of each frequency multiplier.

The integrator, consisting of the bridge diodes and timing capacitors, is switched by the comparator output. This switching causes either the current source or current sink to charge the timing capacitor selected by the frequency multiplier.When the current source is switched in, the charge on the timing capacitor will rise linearily, producing the positive-going triangle slope. Likewise, the current sink produces the negative-going triangle slope.

The triangle amplifier is a unity gain amplifier whose output is fed to the comparator and to the output circuits. The comparator operates as a window detector with limit points set to the triangle peaks. The ± 2V output is sent back to the integrator and timing capacitor.When the output is $+2$V, the triangle is positive-going until the $+1.25$V limit is reached and the comparator output switches to -2V. When the output is -2V, the triangle is negative-going until the -1.25V limit is reached and the comparator output switches back to $+2$V, repeating the process. In this manner, the basic function generator loop, the bold path in figure 4-1, produces simultaneous generation of triangle and square waves at the same frequency.

The output frequency is determined by the magnitude of the timing capacitor selected by the frequency multiplier switches and by the magnitude of the currents supplied to and removed from it. Since the currents are linearily proportional to the sum of the VCG inputs, so will be the output frequency.

To extend the lower frequency capability of the generator, a capacitance multiplier circuit divides VCG currents by 10 (effectively multiplying the timing capacitor by 10) for each of the lower 3 multiplier ranges.

The TTL square from the comparator is sent to the trigger flip flop, the intergrator and the pulse board one-shots. The one-shot pulse (or square) is sent to the square shaper input. When the ⎍ FUNCTION switch is selected, the square shaper is enabled and converts the pulse into a current signal.The buffered triangle is applied to the ∿ FUNCTION switch and to the sine converter input. The sine converter, using the nonlinear characteristics of its diodes, converts the triangle into a sinusoidal current for the ∿ FUNCTION switch.

The selected function is sent to the preamplifier, where it is inverted and buffered. The preamplifier output goes to the output amplifier through the AMPLITUDE control where it is summed with offset voltage from the DC OFFSET control. Here, waveform and offset are inverted and amplified to a 10V peak signal which can drive a 50Ω termination from a 50Ω source impedance. The output amplifier drives the 50Ω OUT HI connector and a resistor divider to produce the 50Ω OUT LO output.

Noncontinuous modes of operation (trigger and gate) result from allowing or preventing the VCG current source from charging the timing capacitor. Whenever the trigger flip-flop output is low, each of the two trigger diodes conduct a current I, sourcing 2 I to the baseline compensation circuit. This removes the current I from the VCG current source and forces a 0V baseline at the triangle amplifier input.

When the CONT switch is released, trigger logic is inhibited from passing any trigger signals and the trigger flip-flop output is held high. This prevents the trigger diodes from conducting and the generator loop operates continuously.

When the CONT switch is pressed, the generator loop is held at th 0V baseline. Pressing the TRIG/GATE switch puts the instrument in triggered mode and any external or manual trigger signals at the trigger logic input will be transformed into a narrow pulse corresponding to the low-to-high transition of the trigger input. This pulse sets the trigger flip-flop high and allows the generator loop to run. When the triangle negative peak is reached, the generator loop again stops. The result is a single cycle generated after the triggering signal corresponding to 0 to 360° of phase. Successive triggered waveforms always start at the same 0° point.

Releasing the TRIG/GATE switch puts the instrument in the gated mode. This is identical to the triggered mode, except the trigger flip-flop is held high for the full duration of the triggering signal. The generator produces continuous waveforms during the time the external signal is high or the manual trigger switch is held in. The last triggered cycle started is always completed and successive gated bursts always start at the 0° point.

4.3 PULSE BOARD

The pulse generator circuitry (figure 4-1) consists of the control logic, delay one-shot, width one-shot, buffer and square shaper.

Selecting ⎍ of the main board, enables the square shaper and allows the signals of one the four pulse modes to be sent to the preamplifier. The square shaper on the main board and the pulse/square output switching on the pulse board determines whether the output pulse will be unipolar (positive or negative pulse) or bi-polar (negative and positive pulse).

The pulse mode switches select one of the four pulse modes. This pulse system uses two one-shots and control logic combinations to generate the desired pulse output. The logic, which is a part of the one-shots, determines the fuunction of the one-shot (delay or width), selects the proper combination of one-shots needed, and determines how the comparator output of the main board is to be used and shaped for triggering purposes. Since both one-shots function the

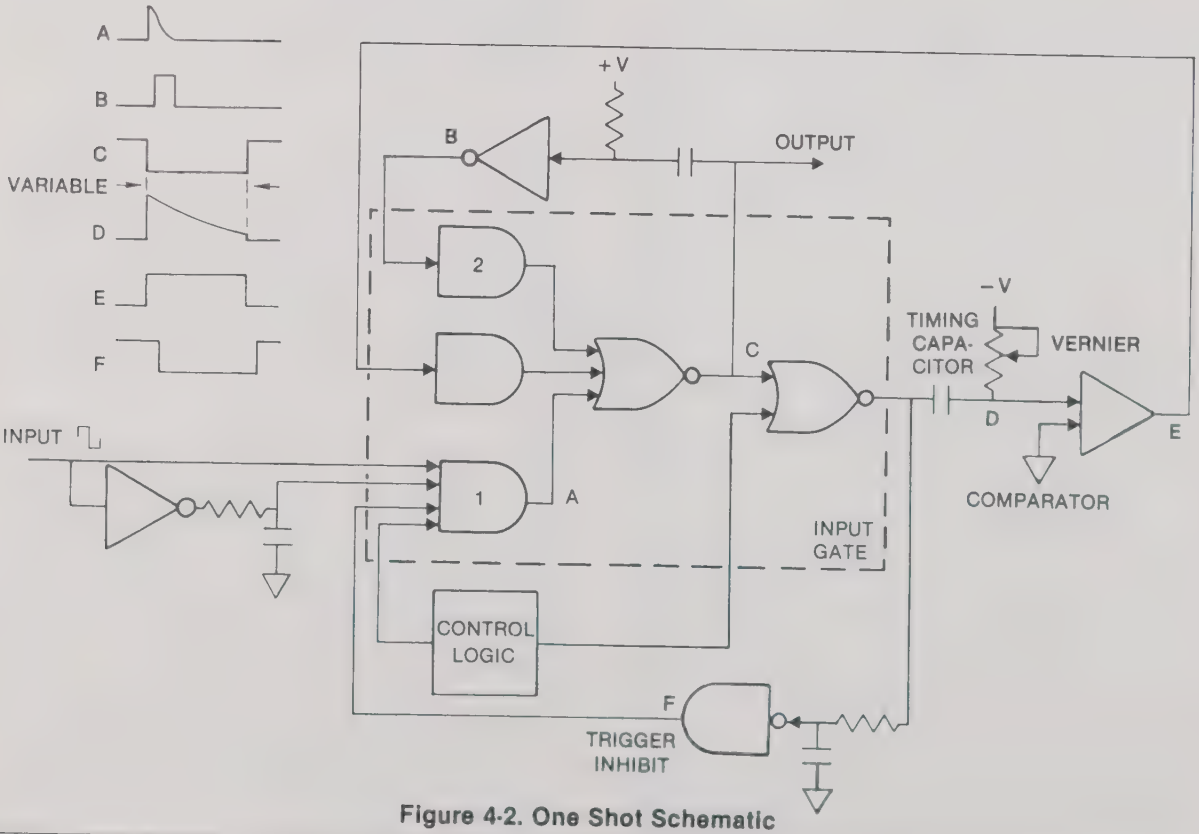


Figure 4-2. One Shot Schematic

same, (figure 4-2) a simplified drawing illustrating one-shot principle of operation is applicable to both one-shots.

An input waveform of any duration is received at two inputs of AND gate 1. Since the signal at one input is inverted and has a RC delay network, the output of gate 1 will have a constant pulse width as shown in waveform (A). The transient spike of pulse (A) is felt at the timing capacitor where the vernier and capacitor create a variable time constant to discharge the pulse as shown by waveform (D). As long as the comparator input (D) is positive, the comparator output (E) will remain positive. This output pulse waveform (E) is fedback, buffered, and inverted before being fed to the output to generate waveform (C). The purpose of AND gate 2, inverter and RC network, is to generate a delayed pulse (B) to latch the output and prevent any spikes. The output of trigger inhibit pulse (F) insures that no other incoming pulse will retrigger the timing capacitor until the capacitor times out.

Once the square or desired pulse has been generated, it is sent to the norm/invert switch where the signal can be inverted relative to the sync out. The signal after being buffered is sent on to the square shaper.

The square shaper is involved in all four pulse modes; refer to sheet 1 of the main generator schematic 0103-00-0850. The square shaper is activated by placing a reverse bias on either CR31 for positive pulse or CR30 for negative pulse. Both are reversed bias for bipolar operation. By pressing ⎍ of the pulse board, a negative voltage is removed from cathode of CR31, causing it to become reverse biased. Since CR31 removes the positive output pulse from emitter of Q12 while forward biased, the pulse is now forced to travel through CR17 which shapes the output pulse before sending it to the preamplifier. Similarly, pressing ⎎ removes a positive forward bias voltage on the anode of CR30 which shorts the negative pulse. CR30 thus becomes reverse biased and the output of emitter Q13 is allowed to pass through square shaping diode CR18. Output switching for ⎏ simply causes CR30 and CR31 to be reversed simultaneously. Refer to appendix A for voltage values of CR31 cathode and CR30 anode for all output modes and waveform possibilities.

4.3.1 Square

Now refer to pulse board schematic 0103-00-0843 sheet 1. Selecting square causes the control logic to inhibit the delay and width one-shots. This is done by placing a ground on U2 pin 10 and a +5 volts on U3 pin 3 to disengage the width one-shot and by leaving a ground on U4 pin 2 and U5 pin 2, to disengage the delay one-shot.

The comparator output is fed through U4 AND gate pin 6 since pins 4 and 5 are high, to pin 8 of U4 where the signal is inverted. From U4 pin 8 the square goes to U3 pin 8.

The signal is passed through U3 pin 10 (because pin 9 is low) to U2 pin 6. Since AND gate pin 4 and 5 are high, the signal is fed out NOR gate pin 8 and inverted. Here the signal travels on to buffer U1.

Two points can be observed about the control logic for this mode. First, for NOR gates of U4 and U2 to pass any signal, three of the unsused inputs need to be at a logic low. Hence, the control logic must cause three of the AND gates feeding one of the NO gates to be low, and must cause the AND gate which will pass the signal to have all inputs high other than the signal input. Tracing from the square switch to the AND gates of U4 and U2 will reveal how this is accomplished. Note that these criteria must be met in the other modes also. Second, the circuitry which generates a one-shot triggering pulse (A) as illustrated in figure 4-2, is not needed when in square mode. Hence, the control logic effectively disables U4 pins 1 and 11 triggering input signal by grounding pin 13 of U4 and disables U2 11 and 12 by placing a +5 volts on U3 pin 5 (thus placing a low on U2 pin 12).

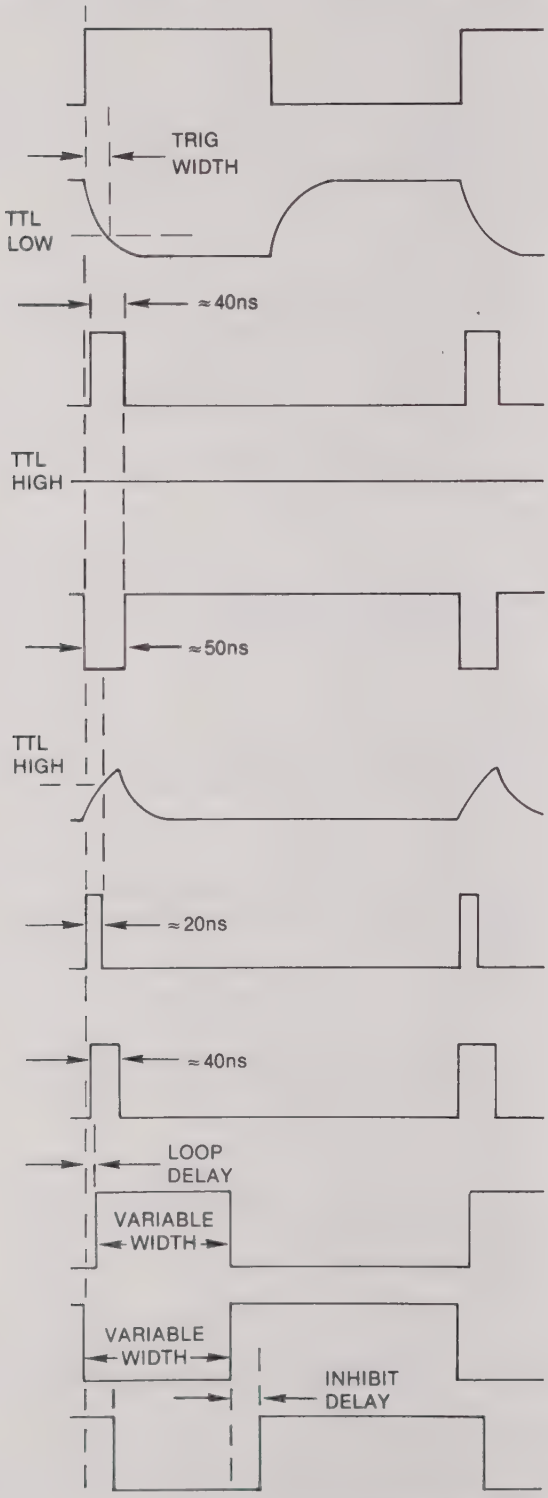
4.3.2 Delay Off

In DLY OFF mode the control logic inhibits the delay one-shot and enables the width one-shot. The delay one-shot is inhibited in the same manner as described for square mode. The width one-shot is enabled by placing a high on U2 pin 10 and placing a low on U3 pin 3. U4 AND gate pins 1 and 11 are enabled by placing a high on U2 pin 10 and placing a low on U3 pin 3. U4 AND gate pins 1 and 11 are enabled which causes a trigger pulse of constant duration from NOR gate pin 8. The negative transition of this pulse is fed to U3 pin 8 and is inverted and delayed before being fed to pin 9 of U3. The resulting output of U3 pin 10 is a smaller pulse width than that observed at pin 8 of U4 and a pulse which is positive. This pulse then triggers the one-shot in a manner as described for figure 4-2. Added to this one-shot are the timing capacitors for greater width variation. Refer to appendix B for voltage values of Q6, Q7 and Q8. Refer to figure 4-3

for timing and detailed point by point tracing of DLY OFF.

4.3.3 Delay On

In DLY ON mode the input control logic enables both one-shots. The width one-shot is enabled as described for DLY OFF and the pulse delay one-shot is enabled by placing a +5 volts on U4 pin 2 and U5 pin 2. The positive transition of the square wave triggers the delay one-shot. This results in an output at U4 pin 8 that has a variable low because of pulse width one-shot. Again this works as described for figure 4-2 with added capactitors to increase the delay pulse. The width one-shot is now set to trigger on the positive transition of the delay pulse. This is done by disabling U2 AND gate pin 5 to process the positive transition from U4 pin 8. The resulting triggering pulse corresponds to pulse (A) of figure4-2. This trigger pulse will be felt at U2 pin 8 and will trigger the width one-shot. The width pulse will be variable as in DLY OFF. Refer to figure 4-4 for a more complete examination of this mode.



U4-11. Input Square.

U4-1. Input Square Inverted and Delayed by R11, C3. Anded with Square for Trigger Pulse.

U4-9,10. Trigger Regeneration.

U4-12. Inhibit Signal.

U4-8. U4 Output (Constant Width Since Delay One-Shot Disabled). Fed to Width One-Shot.

U3-9. Previous Signal Inverted and Delayed by R27, C13.

U3-10. Previous Two Signals Nored together to Give Short Positive Trigger.

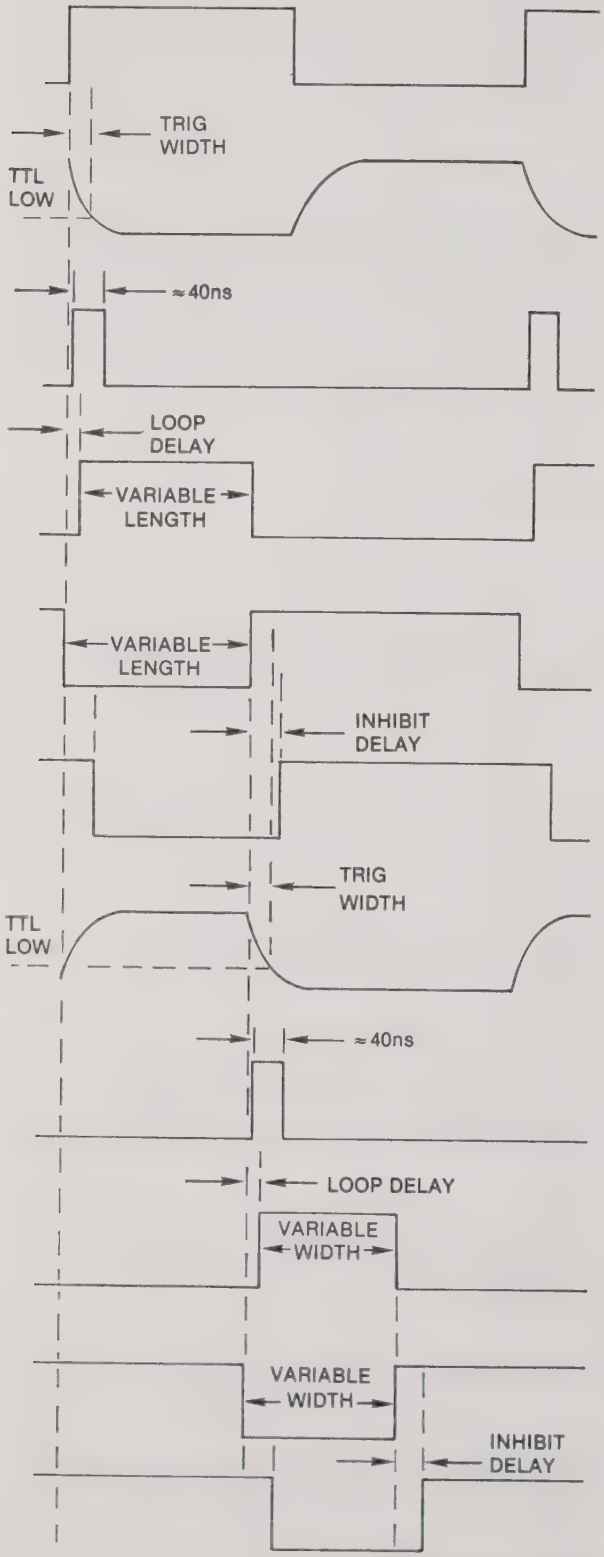
U2-2,3. Trigger Regeneration. Latches One-Shot to Allow Time for Feedback to U2-9 to Arrive.

U2-9. Loop Feedback. Width Governed by C17, R22 (WIDTH Vernier).

U2-8. Variable Width Pulse. Fed to Output.

U2-4. Inhibit. Delayed by R31, C16 to Allow One-Shot Time to Reset before next Trigger.

Figure 4-3 Delay Off Mode Timing Chart



U4-11. Input Square.

U4-1. Input Square Inverted and Delayed by R11, C3. Anded with Square for Trigger Pulse.

U4-9,10. Trigger Regeneration. Latches One-Shot to Allow Time for Loop Feedback to Arrive.

U4-3. Loop feedback. Width determine by C6, R6 (DELAY vernier)

U4-8. Variable Length Delay Pulse. Positive Transition Will Trigger Output Pulse.

U4-12. Inhibit. Delay by R12, C5 to Allow One-Shot Time to Reset before Next Trigger.

U2-12. Variable Delay Pulse Inverted and Delayed by R28, C14. Anded with Delay Pulse for Trigger.

U2-2,3. Trigger Regeneration. Latches One-Shot to Allow Time for Loop Feedback to Arrive.

U2-9. Loop Feedback. Width Governed by C17, R22 (WIDTH Vernier).

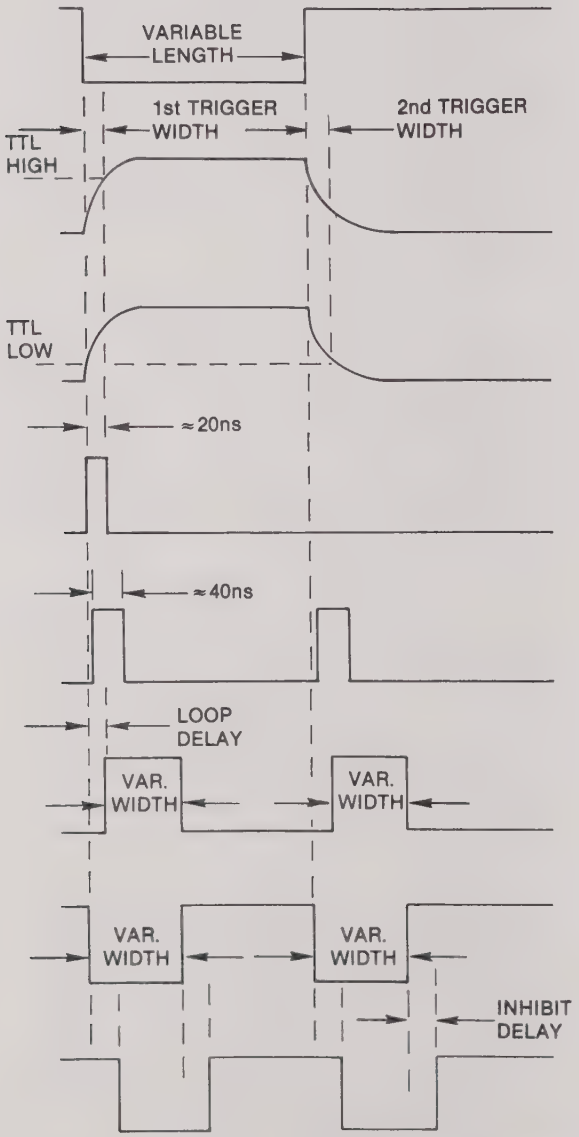
U2-8. Variable Width, Delayed Pulse. Fed to Output.

U2-1. Inhibit. Delayed by R31, C16 to Allow One-Shot Time to Reset before Next Trigger.

Figure 4-4. Delay On Mode Timing Chart

4.3.4 Double Pulse

DBL PULSE works exactly as the delayed pulse except that the logic low on U2 pin 5 is changed to a logic high. This allows the width one-shot to be triggered on the negative transition for U4 pin 8 via U3 pins 8, 9 and 10 and on the positive transition via U3 pins 6, 5 and 4 with AND gate U2 pin 12. For analysis refer to figure 4-5.



U4-8. Delay Pulse (same as Generated in DLY ON Mode).

U3-9. Delay Pulse Inverted and Delayed by R27, C13. Nored with Delay Pulse to Give First Trigger.

U2-12. Delay Pulse Inverted and Delayed by R28, C14. Anded with Delay Pulse to Give Second Trigger.

U2-6. First Trigger Pulse.

U2-2,3. Trigger Regeneration. Latches One-Shot to Allow Time for Loop Feedback to Arrive. Occurs for Both Triggers.

U2-9. Loop Feedback. Widths Governed by C17, R22 (WIDTH Vernier). Both Pulses Have Equal Width.

U2-8. Double Pulse with Variable Width and Delay. Fed to Output.

U2-1,4. Inhibit. Delay by R31, C16 to Allow One-Shot Time to Reset before Next Trigger.

Figure 4-5. Double Pulse Mode Timing Chart

SECTION 5
ALIGNMENT

5.1 FACTORY REPAIR

Wavetek maintains a factory department for those customers not possessing the necessary personnel or test equipment to maintain the instrument. If an instrument is returned to the factory for alignment or repair, a detailed description of the specific problem should be attached to minimize turnaround time.

5.2 REQUIRED TEST EQUIPMENT

Voltmeter . . Millivolt dc measurement (1% accuracy)
Oscilloscope . . . . . ≥60 MHz bandwidth
Counter . . . . . 4 MHz (0.1% accuracy)
50Ω Feedthru . . . . . ±1% accuracy, 2W
Distortion Analyzer . . . . . To 400 kHz
RG58U Coax Cable . . . 3 ft length BNC male contacts

5.3 REMOVING GENERATOR COVERS

1. Invert the instrument and remove the four screws in the bottom cover (ref: drawing 0102-00-0844 in section 7).

2. Turn the instrument upright; remove the top cover for access to generator alignment controls.

3, For access to the pulse board, remove the screws securing the bottom cover to the generator board, replace the top cover invert the instrument and remove the bottom cover.

4. When alignment is complete, secure both covers.

NOTE

Remove the cover only when it is necessary to make adjustments or measurements.

5.4 ALIGNMENT

After referring to the following preliminary data, perform alignment, as necessary, per table 5-1. If performing partial alignment, check previous settings and adjustments for applicability. See figures 5-1 and 5-2 for alignment control location.

1. All measurements made at the FUNCTION OUT connector must be terminated into a 50Ω (±1%) load.

2. Start the alignment by connecting the unit to an appropriate ac power source and setting the front panel switches as follows.

POWER . . . . . ON
Frequency Dial 4.0
FREQ MULT (Hz) . . . . . ×1K
MODE CONT . . . . . CONT (released)
FUNCTION . . . . . ⎍
DC OFFSET . . . . . OFF
AMPLITUDE . . . . . MAX
PULSE MODE . . . . . ⎍
PULSE/SQUARE
OUTPUT . . . . . NORM (released), ⎍

3. Allow the unit to warm up at least 30 minutes for final alignment. Keep the instrument cover on to maintain heat. Remove cover only to make adjustments or measurements.

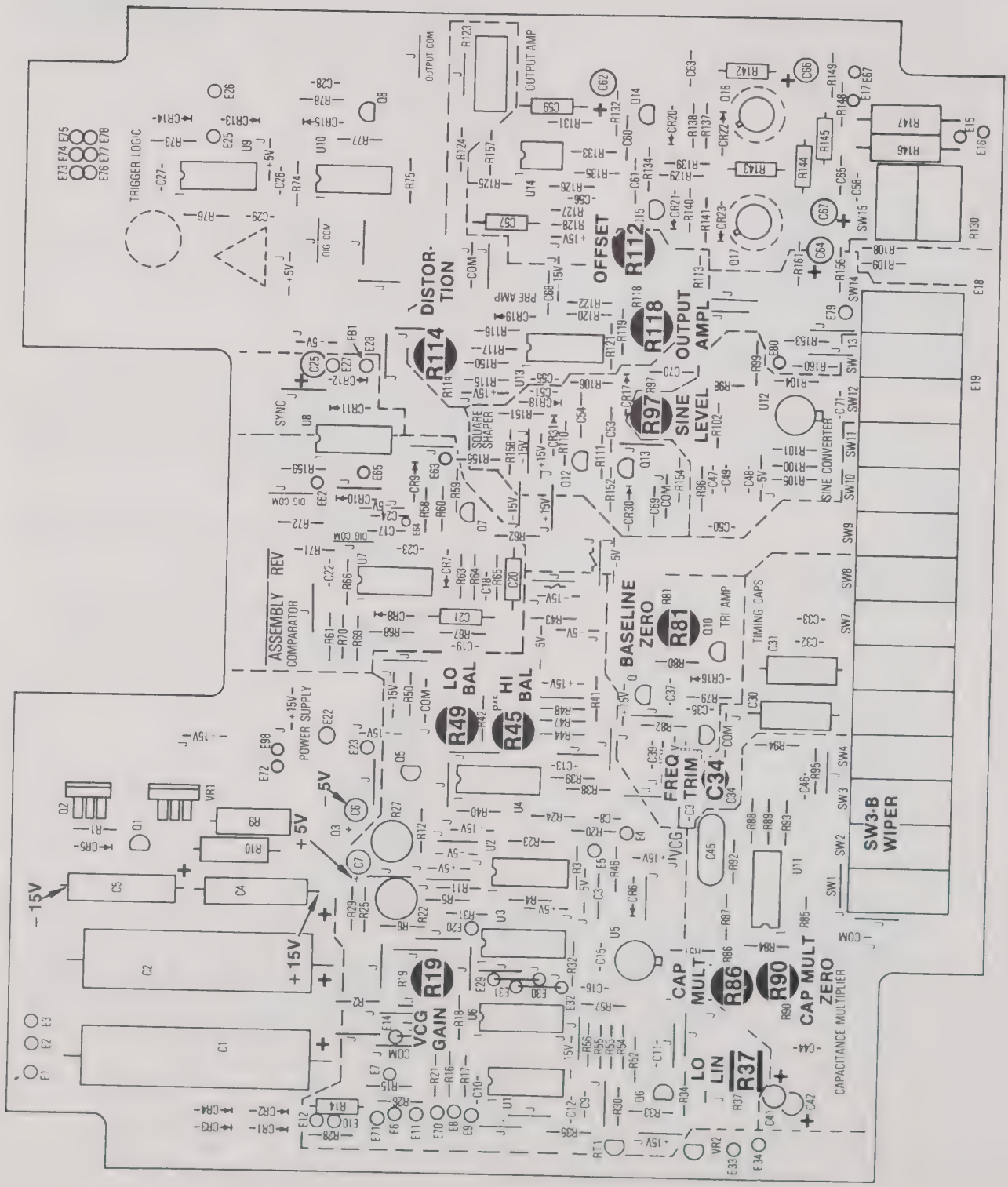


Figure 5-1. Generator Board Alignment Points

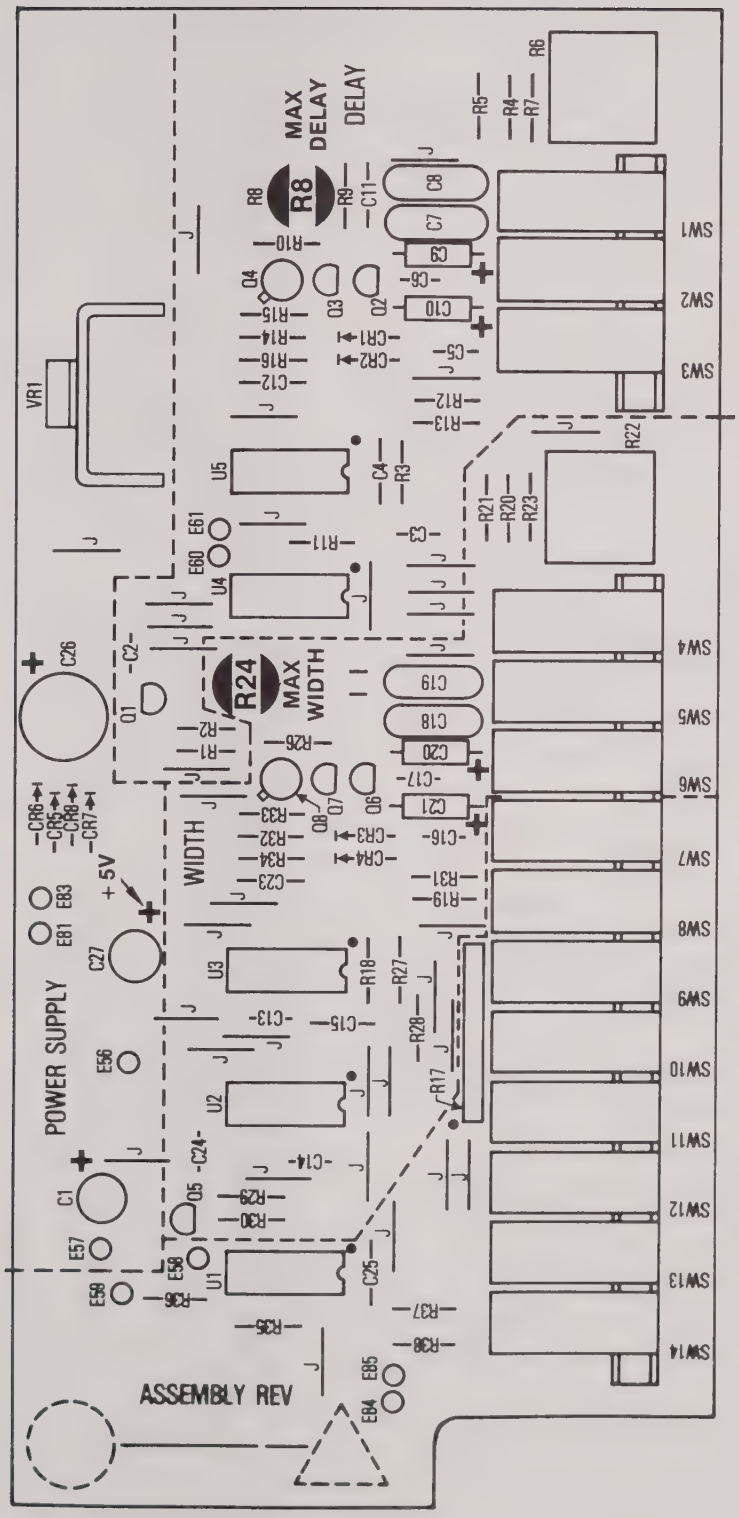


Figure 5-2. Pulse Board Alignment Points

Table 5-1. Alignment Procedure

NOTE: Open columns indicate previous entry remains applicable.

Step	Check	Tester	Test Point	Control Setting	Adjust	Result	Remark
1	Power Supply	Voltmeter	C4 +	Paragraph 5.4, Step 2		+ 15 ± .75V	Verify ± 15V should track within 30 mV
2			C5 –			– 15 ± .75V	
3			C7 +			+ 5 ± .25V	Verify.
4			C6 –			– 5 ± .25V	
Replace top cover, turn the instrument over and remove the bottom cover, make check of step 5 and replace the cover, turn the instrument over again and continue with step 6.							
5			C27 +			+ 5 ± .25V	
6	Capacitor Multiplier Zero		SW3-B		R90 CAP MULT ZERO	0V ± 2mV	
7	Approximate Bottom of the Dial Frequency	Counter	50Ω OUT HI (terminate into 50Ω)	Dial: .004 FREQ MULT: 10K	R37 LO LIN	20 to 25 ms period	
8	Bottom of the Dial Symmetry	Scope			R49 LO BAL	Equalize (+) and (–) half cycles	Set scope to (–) trigger; display one full cycle. Align positive transition to center of screen. Multiply the horizontal display × 10. Set scope to (+) trigger; adjust R49 to align negative transition with center of screen
9	Bottom of the Dial Frequency	Counter		FREQ MULT: × 1K	R37 LO LIN	350 ± 50 ms period	
10	Top of the Dial Symmetry	Scope		Dial: 4.0	R45 HI BAL	Equalize (+) and (–) half cycles	Same method as step 8, except adjust R45.
11	Top of the Dial Frequency	Counter		Dial: 4.0 FREQ MULT: × 1K	R19 VCG GAIN	4 + .02 kHz	
12				FREQ MULT: × 10K		40 ± .8 kHz	Verify
13				FREQ MULT: × 1M	C34 FREQ TRIM	4 ± .02 MHz	
14				FREQ MULT: × 100K		400 ± 8 kHz	Verify. If necessary, trim by changing value of C33
15				FREQ MULT: × 100	R86 CAP MULT	2.5 ± .05 ms	
16				FREQ MULT: × 10		25 ± .5 ms	Verify

Table 5-1. Alignment Procedure (Continued)

Step	Check	Tester	Test Point	Control Setting	Adjust	Result	Remark
17				FREQ: ×1		250 ±5 ms	Verify
18	Sine Distortion	Distortion Analyzer		FUNCTION: ∿ FREQ MULT: ×1K	R97 SIN LEVEL R114 DISTOR-TION	Adjust for minimum distortion	It may be necessary to reduce amplitude to 5V peak
19	Output Amplitude	Scope		FUNCTION: ∿	R118 OUTPUT AMPL	10 Vp-p (+.3V/−0V)	
20	Output Offset	Voltmeter		FUNCTION: ∿	R112 OFFSET	0 ±50 mV	
21	Baseline Zero	Scope		MODE: Trigger	R81 BASELINE ZERO	0 ±75 mV	It may be necessary to trim the baseline with R80
Replace top cover, turn the instrument over and remove the bottom cover. The following adjustments will be on the pulse board.							
22	Pulse Width			MODE: CONT FREQ MULT: 10K FUNCTION: ⎍ PULSE MODE: DLY OFF WIDTH RANGE: .1μs-10μs WIDTH Vernier: MAX PULSE/SQUARE: ⎍	R24 MAX WIDTH	12 (−0/+1) μs pulse width as shown in fig. 5-3.	Scope horizontal: 2 μs/div Scope trigger. External Trigger Source: 187 SYNC OUT.
23	Pulse Delay			PULSE MODE: DLY ON DELAY RANGE: .1μs-10μs DELAY Vernier: MAX	R8 MAX DELAY	12 (−0/+1) μs pulse delay as shown in fig. 5-4.	Pulse delay is relative to sync output.

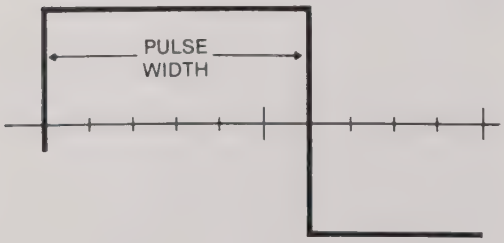


Figure 5-3. Pulse Width

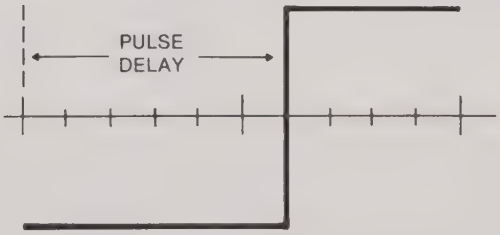


Figure 5-4. Pulse Delay

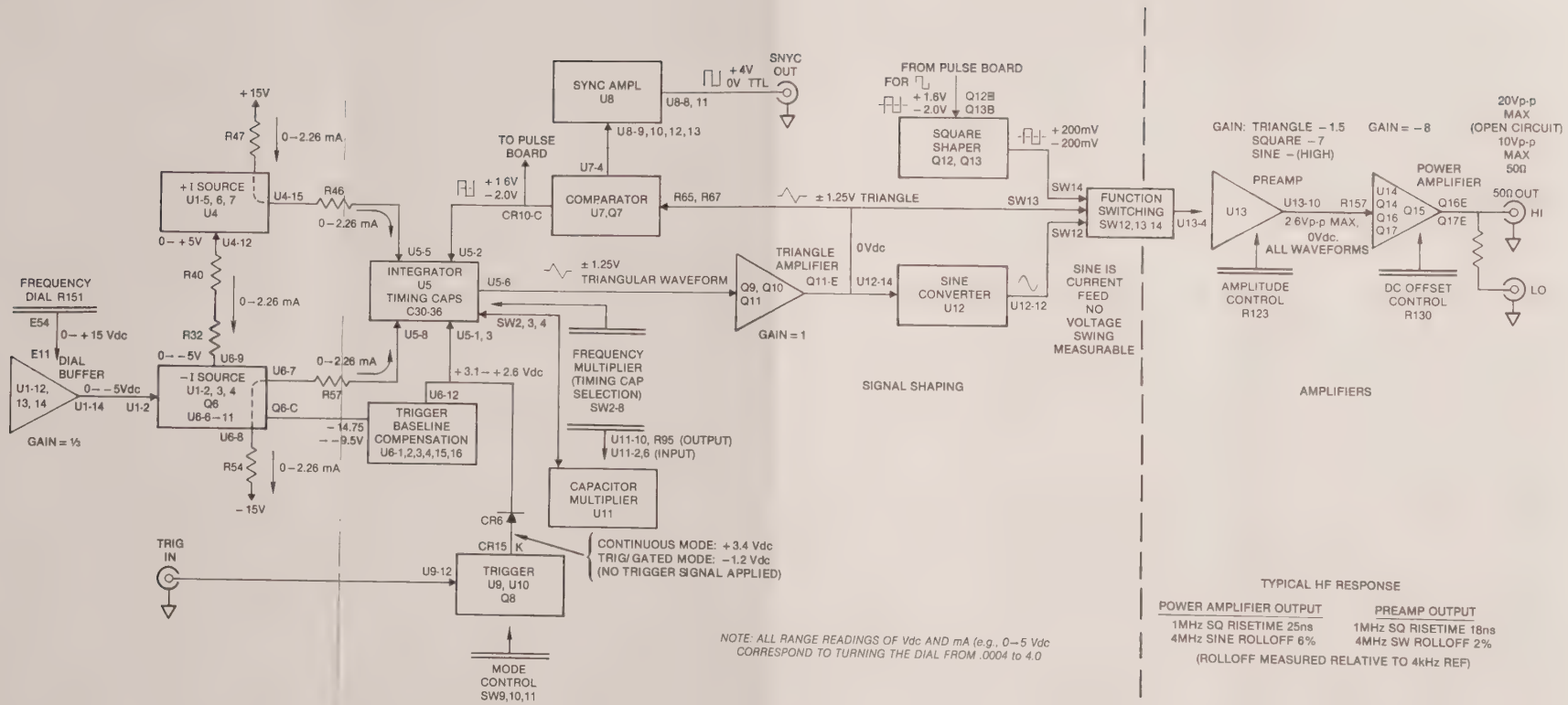


Figure 6-1. Generator Board Troubleshooting Block Diagram

SECTION 6
TROUBLESHOOTING

6.1 FACTORY REPAIR

Wavetek maintains a factory repair department for those customers not possessing the necessary personnel or test equipment to maintain the instrument. If an instrument is returned to the factory for alignment or repair, a detailed description of the specific problem should be attached to minimize turnaround time.

6.2 BEFORE YOU START

CAUTION

To prevent damage to components, turn unit off while removing or replacing components, connectors or pc boards.

Since no troubleshooting guide can possibly cover all the potential problems, the aim of this guide is to give a methodology which if applied consistently will lead to the problem area.

This troubleshooting guide is arranged to aid you in meeting the following goals.

1. Symptom recognition (listing of possible problem).
2. Symptom elaboration (front panel manipulation to isolate problems).
3. Isolation to the faulty function.
4. Isolation to the faulty circuit.
5. Isolation to the faulty component.

The functional blocks and their purpose are listed in table 6-1 as a supplement to figures 4-1 and 6-1. All information presented will revolve around this list. Figure 6-1 is the generator board portion of figure 4-1 annoted with troubleshooting data.

Table 6-1. Purpose of Each Circuit

Functional Block	Purpose
Power Supply	Supply regulated ±15 Vdc and ±5 Vdc to all circuits.
Dial Buffer	Buffer amplifier (voltage gain = −⅓). For isolation between the frequency dial pot and the following circuits.
−I Source	Constant current source (negative). The output level of which can be set from 0 to approximately 2.26 mA by the output of the dial buffer. The current output, applied to the integrator, results in the linear negative-going triangle slope. The −I source also outputs a second 0 to 2.26 mA to the +I source.
+I Source	Constant current source (positive). The output level of which can be set from 0 to approximately 2.26 mA by the output (U6-9) of the −I source. The current output, applied to the integrator, results in the linear positive-going triangle slope.

Table 6-1. Purpose of Each Circuit (continued)

Functional Block	Purpose
Integrator	Forms a linear triangular waveform as a result of alternate application of + and − charging current to a timing capacitor. Alternation is controlled by a square-wave signal applied from the comparator. This is accomplished through the use of a diode bridge, timing capacitors and appropriate range switching.
Triangle Buffer	Unity-gain FET-input noninverting buffer amplifier. Provides sufficient drive for the following circuits.
Comparator	Monitors the output of the triangle buffer and provides a control signal to the integrator that results in the generation of alternate positive- and negative- going linear ramps. The input of the comparator contains peak detection circuits that determine the ±1.25V peak levels of the resultant triangular Waveform. The input circuits also contain R-C lead networks which "roll off" the triangle peaks during high frequency operation. The networks compensate for normal circuit delays, thus maintaining good dial tracking in the X100K and X1M frequency ranges. The control signal output to the integrator takes the form of a square wave which is also applied to trigger, sync and square shaper circuits.
Capacitor Multiplier	Used only in X1, X10 and X100 frequency multiplier ranges, this circuit shunts 90% (in X100), 99% (in X10) or 99.9% in (X1) of the current available from the ± I sources away from the timing capacitor, effectively "multiplying" the value of the timing capacitor by 10, 100 or 1000.
Sync Amplifier	Provides TTL level square wave (fan-out of 20) at the generator frequency to the front panel.
Trigger	Provides non-continuous generator operation by controlling application of the ± charging currents to the timing capacitor. In triggered mode, one cycle of waveform is generated each time the trigger input is driven to a TTL high level. In gated mode, the generator continues to run as long as the trigger input is held at a TTL high.
Trigger Baseline Compensation	Ensures that the output of the integrator remains at 0Vdc in triggered/gated operation with no trigger input.

Table 6-1. Purpose of Each Circuit (continued)

Functional Block	Purpose
Square Shaper	Conditions the square wave from the comparator to proper amplitude and waveshape by clipping the top and bottom of the waveform.
Sine Coverter	Inputs triangular waveform and, through the use of nonlinear resistor-diode circuitry, outputs a sinusoidal current.
Preamp	Inputs selected waveform and amplifies it to 2.6Vp-p for input to the power amplifier. Gain is −1.5 in triangle, −7 in square. It is current fed.
Power Amplifier	Complementary symmetry amplifier. Capable of delivering 10Vp-p into 50Ω. Gain is −8 (open circuit) −4 (into 50Ω)
Width One-shot	Variable Width.
Delay One-shot	Variable Delay
Control Logic	Control.

6.3 STARTING

When confronted with a problem, intially check the power supplies (figure 6-2). Once the power supplies are determined to be good, use the front panel manipulation to isolate the problem and refer to table 6-2, an index of the troubleshooting tables by indications of common problems. Table 6-2 and referenced figures do not cover every possible trouble, but, when used in conjunction with circuit descriptions and schematics, will be an aid in systematically isolating faulty components.

Once the problem is isolated to the smallest possible number of components, test individual components. Paragraph 6.4 suggests methods of testing many of the commonly used components.

6.4 TROUBLESHOOTING INDIVIDUAL COMPONENTS

6.4.1 Transitor

1. A transistor is defective if more than one volt is measured across its base-emitter junction in the forward direction.
2. A transistor when used as a switch may have a few volts reverse bias voltage across base emitter junction.
3. If the collector and emitter voltages are the same, but the base emitter voltage is less than 500mV forward voltage (or reversed bias), the transitor is defective.
4. A transistor is defective if its base current is larger than 10% of its emitter current (calculate currents from voltage across the base and emitter series resistors).
5. In a transistor differential pair (common emitter stages), either their base voltages are the same in normal operating condition, or the one with less forward voltage across its base emitter junction should be off (no collector current); otherwise, one of the transistors is defective.

6.4.2 Diode

A diode (except a zener) is defective if there is greater than one volt (typically 0.7 volt) forward voltage across it.

Table 6-2. Fault Isolation

Note: Return as many of the front panel controls as possible to their initial settings and still retain the problem. The troubleshooting tables generally begin at these initial settings and specify all subsequent setups. Preset the front panel controls as follows:

Control	Position
Frequency Dial	4.0
POWER	ON
MODE	CONT
FREQ. MULT	1K
FUNCTION	
PULSE MODE	
PULSE/SQUARE OUTPUT	NORM,
DC OFFSET	OFF
AMPLITUDE	MAX

Problem	Figure
Power Supply	6-2
Symmetry or Frequency (Power Supplies OK)	6-3
Improper Amplitude or Waveshape of Any Function	6-5
No Output (Power Supplies OK)	6-6
No Square and Pulse Output Only (Power Supplies OK)	6-7

6.4.3 Operational Amplifier

1. The "+" and "−" inputs of an operational amplifier will have less than 15 mV voltage difference when operating under normal conditions.

2. When the output of the amplifier is connected to the "−" input (voltage follower connection), the output should be the same voltage as the "+" input voltage; otherwise, the operational amplifier is defective.

3. If the output voltage stays at maximum positive, the "+" input voltage should be more positive than "−" input voltage, or vice versa; otherwise, the operational amplifier is defective.

6.4.4 FET Transistor

1. No gate current should be drawn by the gate of an FET transistor. If so, the transistor is defective.

2. The gate-to-source voltage is always reverse biased under a normal operating condition; e.g., the source voltage is more positive than the gate voltage for 2N5485, and the source voltage is more negative than gate voltage for a 2N5462. Otherwise, the FET is defective.

3. If the device supplying gate voltage to an FET saturates, the FET has too large a Vgs (pinch off) for the circuit and should be replaced.

6.4.5 Capacitor

1. Shorted capacitors have zero volts across their terminals.

2. Opened capacitor can be located (but not always) by using a good capacitor connected in parallel with the capacitor under test and observing the resulting effect.

6.4.6 Digital TTL IC's (e.g. 7400 Series)

1. The device is operating correctly if the output high state is $> +2.4$V and low state is $< +0.5$V.

2. The input must show the same two levels as in step 1. If the levels are between $+0.8$V and $+2.0$V, the connection to the driving circuit output is open.

Figure 6-2. Power Supply Troubleshooting (Sheet 1)

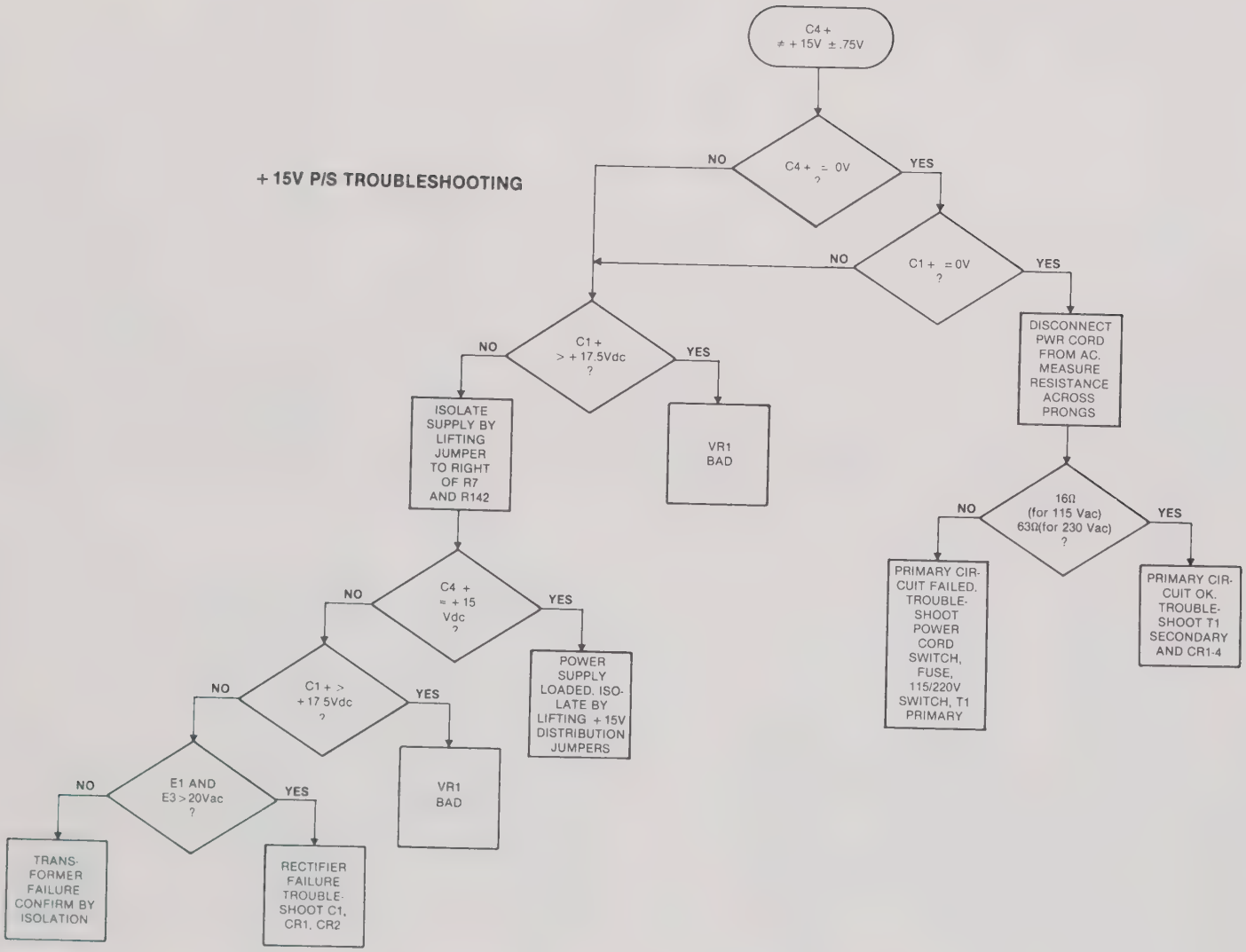


Figure 6-2. Power Supply Troubleshooting (Sheet 2)

– 15V P/S TROUBLESHOOTING

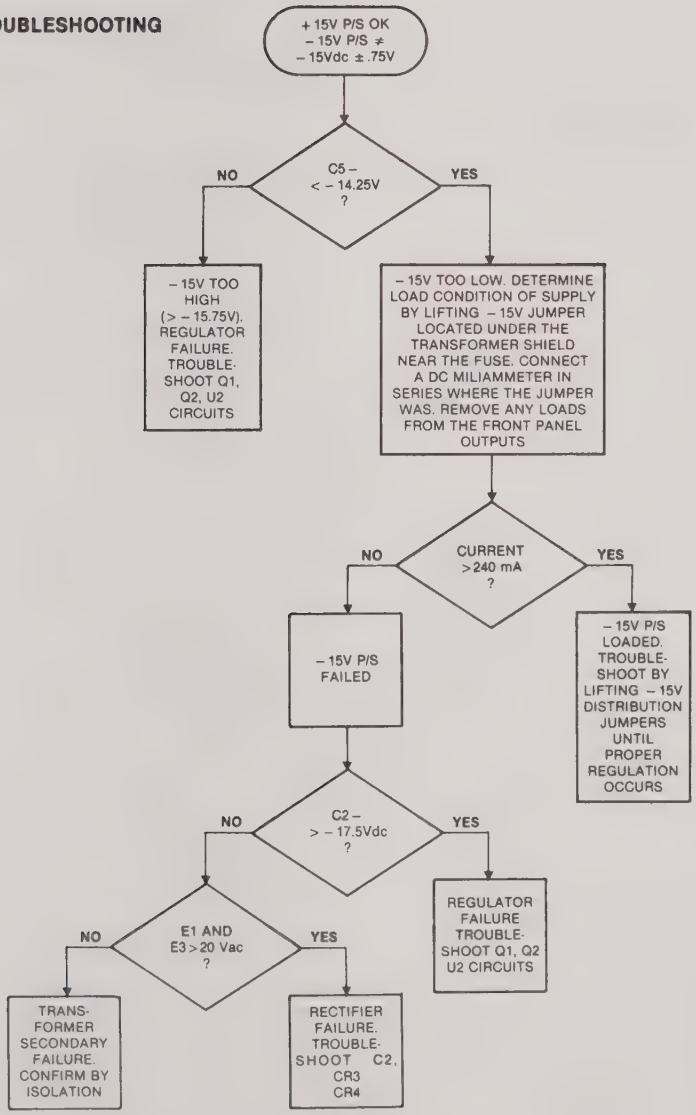

+ 15V P/S OK
– 15V P/S ≠
– 15Vdc ± .75V
C5 –
< – 14.25V
?
NO
YES
– 15V TOO HIGH (> – 15.75V). REGULATOR FAILURE. TROUBLE-SHOOT Q1, Q2, U2 CIRCUITS
– 15V TOO LOW. DETERMINE LOAD CONDITION OF SUPPLY BY LIFTING – 15V JUMPER LOCATED UNDER THE TRANSFORMER SHIELD NEAR THE FUSE. CONNECT A DC MILIAMMETER IN SERIES WHERE THE JUMPER WAS. REMOVE ANY LOADS FROM THE FRONT PANEL OUTPUTS
CURRENT
>240 mA
?
NO
YES
– 15V P/S FAILED
– 15V P/S LOADED. TROUBLE-SHOOT BY LIFTING – 15V DISTRIBUTION JUMPERS UNTIL PROPER REGULATION OCCURS
C2 –
> – 17.5Vdc
?
NO
YES
E1 AND
E3 > 20 Vac
?
NO
YES
REGULATOR FAILURE TROUBLE-SHOOT Q1, Q2 U2 CIRCUITS
TRANS-FORMER SECONDARY FAILURE. CONFIRM BY ISOLATION
RECTIFIER FAILURE. TROUBLE-SHOOT C2, CR3 CR4

Figure 6-2. Power Supply Troubleshooting (Sheet 3)

NOTES ON BOTTOM-OF-DIAL (BOD) FAILURES

If BOD symmetry will not adjust, go to triangle mode and inspect linearity of the waveform.

Curvature of both sides of the triangle indicates a leak on line or in U5. Check BOD on X1K through X1M to check timing capacitors C30-C33. Measure voltage drop across R51: If any current is flowing, problem is in Q9, C34, C35, C36. If no current is flowing, problem is in U5.

A non-symmetrical triangle with or without curvature on one side only is an indication of failure in one current source or a leaky diode in U5. Determination of the failed circuit can be made by the following steps:

1. Measure voltage drop across R32 or R40. These drops should be equal and be in the 2 to 20 mV range.

2. Measure drops across R47 and R54. If either of these voltages is different from that measured in step 1, the problem lies in the circuit which shows the different voltage; that is, if the drop across R47 is different, problem is U4. If the voltage across R54 is different, the problem is U6. If all drops appear good, the problem is probably in U5. If changing U5 yields no improvement, the problem may still be a very small leak on the triangle generation line Q9, C34, C35, C36.

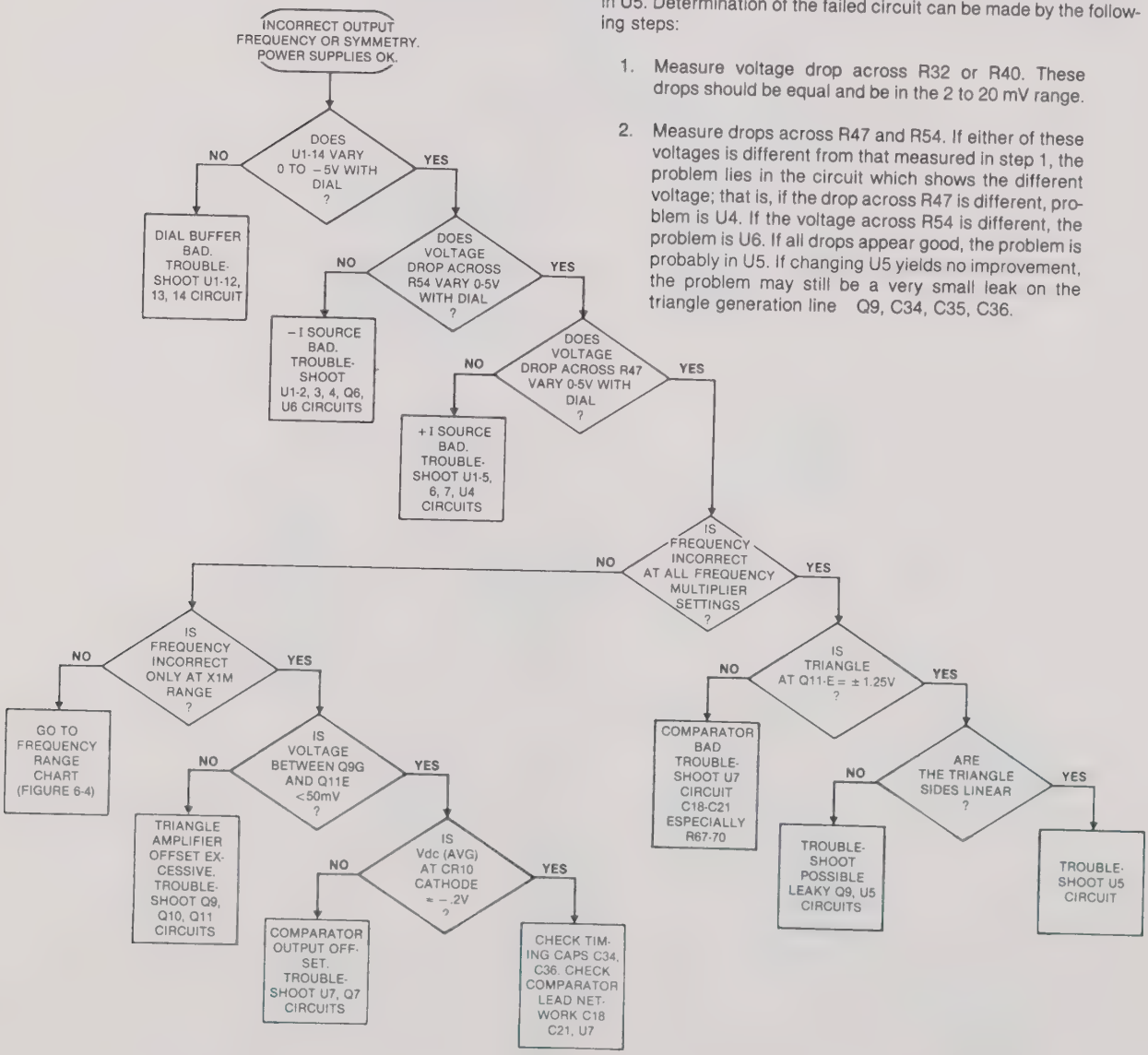

INCORRECT OUTPUT FREQUENCY OR SYMMETRY. POWER SUPPLIES OK.
DOES U1-14 VARY 0 TO −5V WITH DIAL ?
NO
YES
DIAL BUFFER BAD. TROUBLE-SHOOT U1-12, 13, 14 CIRCUIT
DOES VOLTAGE DROP ACROSS R54 VARY 0-5V WITH DIAL ?
NO
YES
−I SOURCE BAD. TROUBLE-SHOOT U1-2, 3, 4, Q6, U6 CIRCUITS
DOES VOLTAGE DROP ACROSS R47 VARY 0-5V WITH DIAL ?
NO
YES
+I SOURCE BAD. TROUBLE-SHOOT U1-5, 6, 7, U4 CIRCUITS
IS FREQUENCY INCORRECT AT ALL FREQUENCY MULTIPLIER SETTINGS ?
NO
YES
IS FREQUENCY INCORRECT ONLY AT X1M RANGE ?
NO
YES
GO TO FREQUENCY RANGE CHART (FIGURE 6-4)
IS VOLTAGE BETWEEN Q9G AND Q11E <50mV ?
NO
YES
TRIANGLE AMPLIFIER OFFSET EXCESSIVE. TROUBLE-SHOOT Q9, Q10, Q11 CIRCUITS
IS Vdc (AVG) AT CR10 CATHODE = −.2V ?
NO
YES
COMPARATOR OUTPUT OFFSET. TROUBLE-SHOOT U7, Q7 CIRCUITS
CHECK TIMING CAPS C34, C36. CHECK COMPARATOR LEAD NETWORK C18 C21, U7
IS TRIANGLE AT Q11-E = ± 1.25V ?
NO
YES
COMPARATOR BAD TROUBLE-SHOOT U7 CIRCUIT C18-C21 ESPECIALLY R67-70
ARE THE TRIANGLE SIDES LINEAR ?
NO
YES
TROUBLE-SHOOT POSSIBLE LEAKY Q9, U5 CIRCUITS
TROUBLE-SHOOT U5 CIRCUIT

Figure 6-3. Symmetry or Frequency Problems

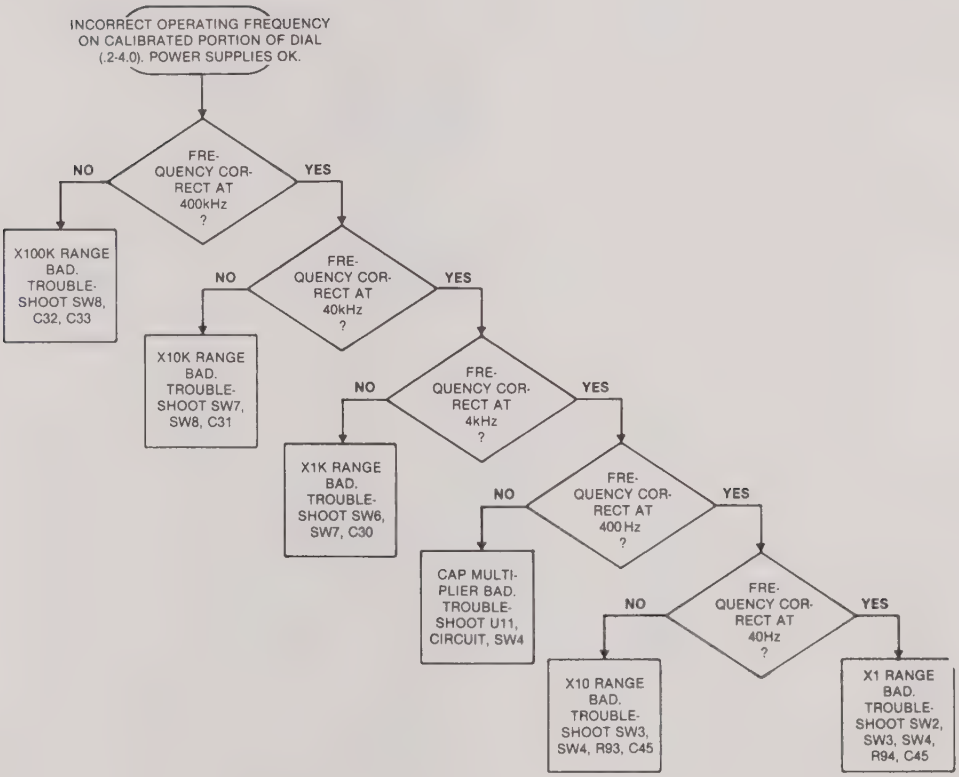

INCORRECT OPERATING FREQUENCY ON CALIBRATED PORTION OF DIAL (.2-4.0). POWER SUPPLIES OK.
FRE-QUENCY COR-RECT AT 400kHz ?
NO
YES
X100K RANGE BAD. TROUBLE-SHOOT SW8, C32, C33
FRE-QUENCY COR-RECT AT 40kHz ?
NO
YES
X10K RANGE BAD. TROUBLE-SHOOT SW7, SW8, C31
FRE-QUENCY COR-RECT AT 4kHz ?
NO
YES
X1K RANGE BAD. TROUBLE-SHOOT SW6, SW7, C30
FRE-QUENCY COR-RECT AT 400 Hz ?
NO
YES
CAP MULTI-PLIER BAD. TROUBLE-SHOOT U11, CIRCUIT, SW4
FRE-QUENCY COR-RECT AT 40Hz ?
NO
YES
X10 RANGE BAD. TROUBLE-SHOOT SW3, SW4, R93, C45
X1 RANGE BAD. TROUBLE-SHOOT SW2, SW3, SW4, R94, C45

Figure 6-4. Frequency Calibration Problems

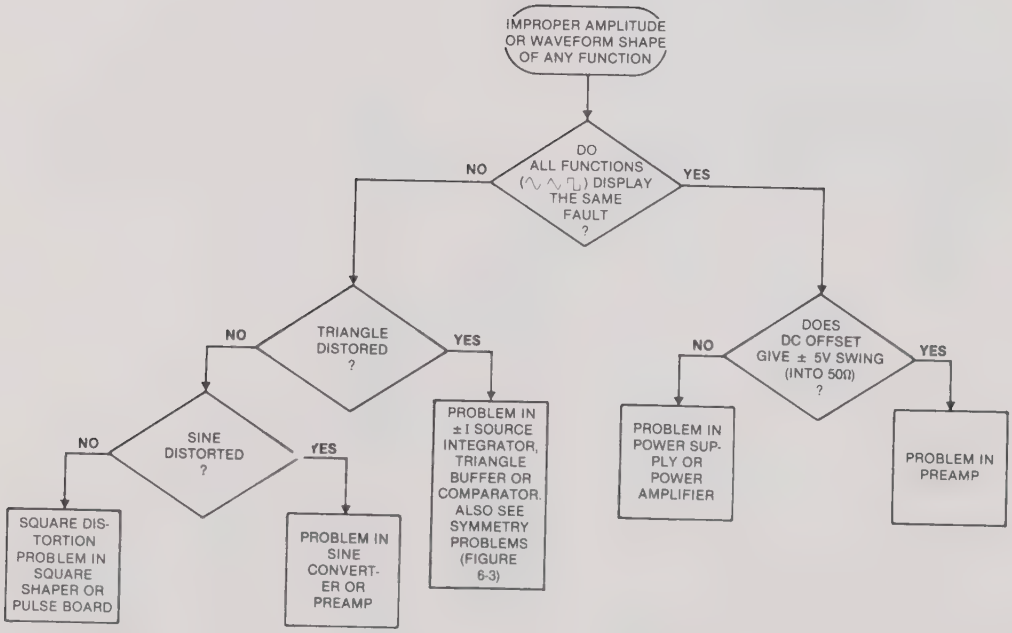

IMPROPER AMPLITUDE OR WAVEFORM SHAPE OF ANY FUNCTION
DO ALL FUNCTIONS (∿ ⩘ ⎍) DISPLAY THE SAME FAULT ?
NO
YES
TRIANGLE DISTORED ?
NO
YES
SINE DISTORTED ?
NO
YES
SQUARE DISTORTION PROBLEM IN SQUARE SHAPER OR PULSE BOARD
PROBLEM IN SINE CONVERTER OR PREAMP
PROBLEM IN ± I SOURCE INTEGRATOR, TRIANGLE BUFFER OR COMPARATOR. ALSO SEE SYMMETRY PROBLEMS (FIGURE 6-3)
DOES DC OFFSET GIVE ± 5V SWING (INTO 50Ω) ?
NO
YES
PROBLEM IN POWER SUPPLY OR POWER AMPLIFIER
PROBLEM IN PREAMP

Figure 6-5. Improper Amplitude or Waveshape

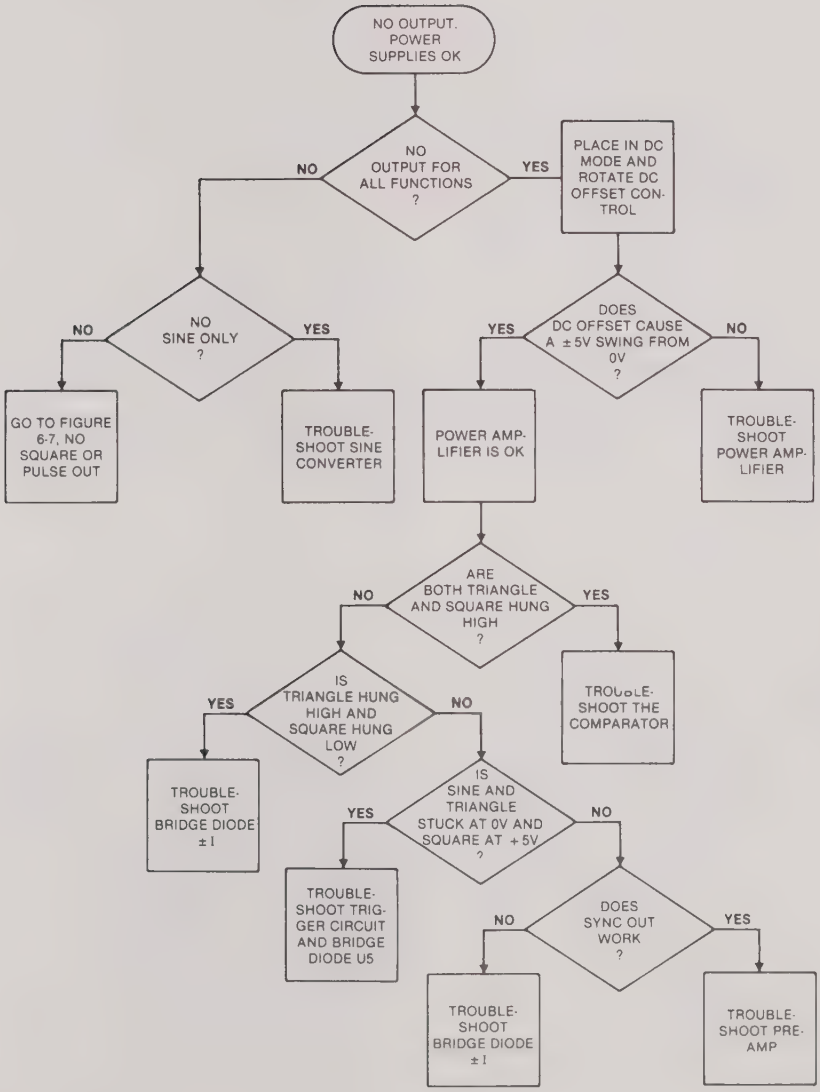


Figure 6-6. No Output

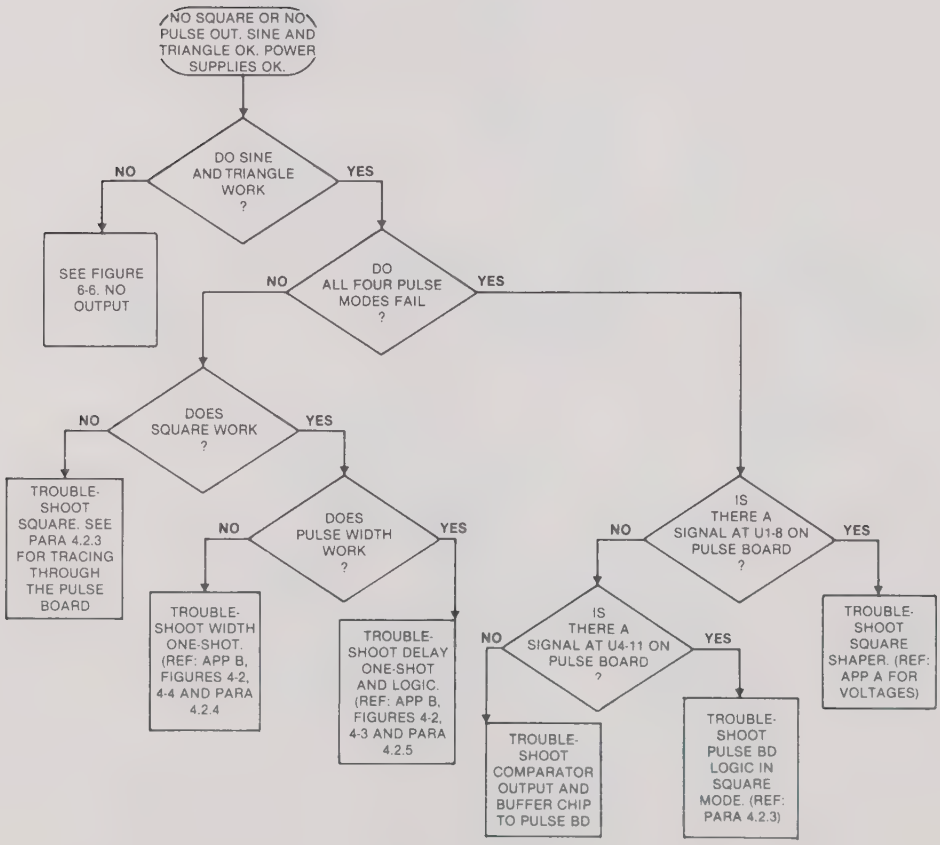

NO SQUARE OR NO PULSE OUT, SINE AND TRIANGLE OK. POWER SUPPLIES OK.
DO SINE AND TRIANGLE WORK ?
NO
YES
SEE FIGURE 6-6. NO OUTPUT
DO ALL FOUR PULSE MODES FAIL ?
NO
YES
DOES SQUARE WORK ?
NO
YES
TROUBLE-SHOOT SQUARE. SEE PARA 4.2.3 FOR TRACING THROUGH THE PULSE BOARD
DOES PULSE WIDTH WORK ?
NO
YES
TROUBLE-SHOOT WIDTH ONE-SHOT. (REF: APP B, FIGURES 4-2, 4-4 AND PARA 4.2.4
TROUBLE-SHOOT DELAY ONE-SHOT AND LOGIC. (REF: APP B, FIGURES 4-2, 4-3 AND PARA 4.2.5
IS THERE A SIGNAL AT U1-8 ON PULSE BOARD ?
NO
YES
TROUBLE-SHOOT SQUARE SHAPER. (REF: APP A FOR VOLTAGES)
IS THERE A SIGNAL AT U4-11 ON PULSE BOARD ?
NO
YES
TROUBLE-SHOOT COMPARATOR OUTPUT AND BUFFER CHIP TO PULSE BD
TROUBLE-SHOOT PULSE BD LOGIC IN SQUARE MODE. (REF: PARA 4.2.3)

Figure 6-7. No Square or No Pulse Output Only

SECTION 7
PARTS AND SCHEMATICS

7.1 DRAWINGS

The following assembly drawings (with parts lists) and schematics are in the arrangement shown below.

7.2 ADDENDA

Under Wavetek's product improvement program, the latest electronic designs and circuits are incorporated into each Wavetek instrument as quickly as develop ment and testing permit. Because of the time needed to compose and print instruction manuals, it is not always possible to include the most recent changes in the initial printing. Whenever this occurs, addendum pages are prepared to sumarize the changes made and are inserted immediately inside the rear cover. If no such pages exist, the manual is correct as printed.

7.3 ORDERING PARTS

When ordering spare parts, please specify part number, circuit reference, board, serial number of unit, and, if applicable, the function performed.

NOTE

An assembly drawing number is not necessarily the assembly part number. However, the assembly parts list number is the assembly part number.

Drawing	Drawing No.
Instrument Schematic	0004-00-0174
Chassis Assembly	0102-00-0844
Chassis Parts Lists	1101-00-0844
Generator Board Schematic	0103-00-0850
Generator Board Assembly	1100-00-0850
Generator Board Parts List	1100-00-0850
Pulse Board Schematic	0103-00-0843
Pulse Board Assembly	1100-00-0843
Pulse Board Parts List	1100-00-0843

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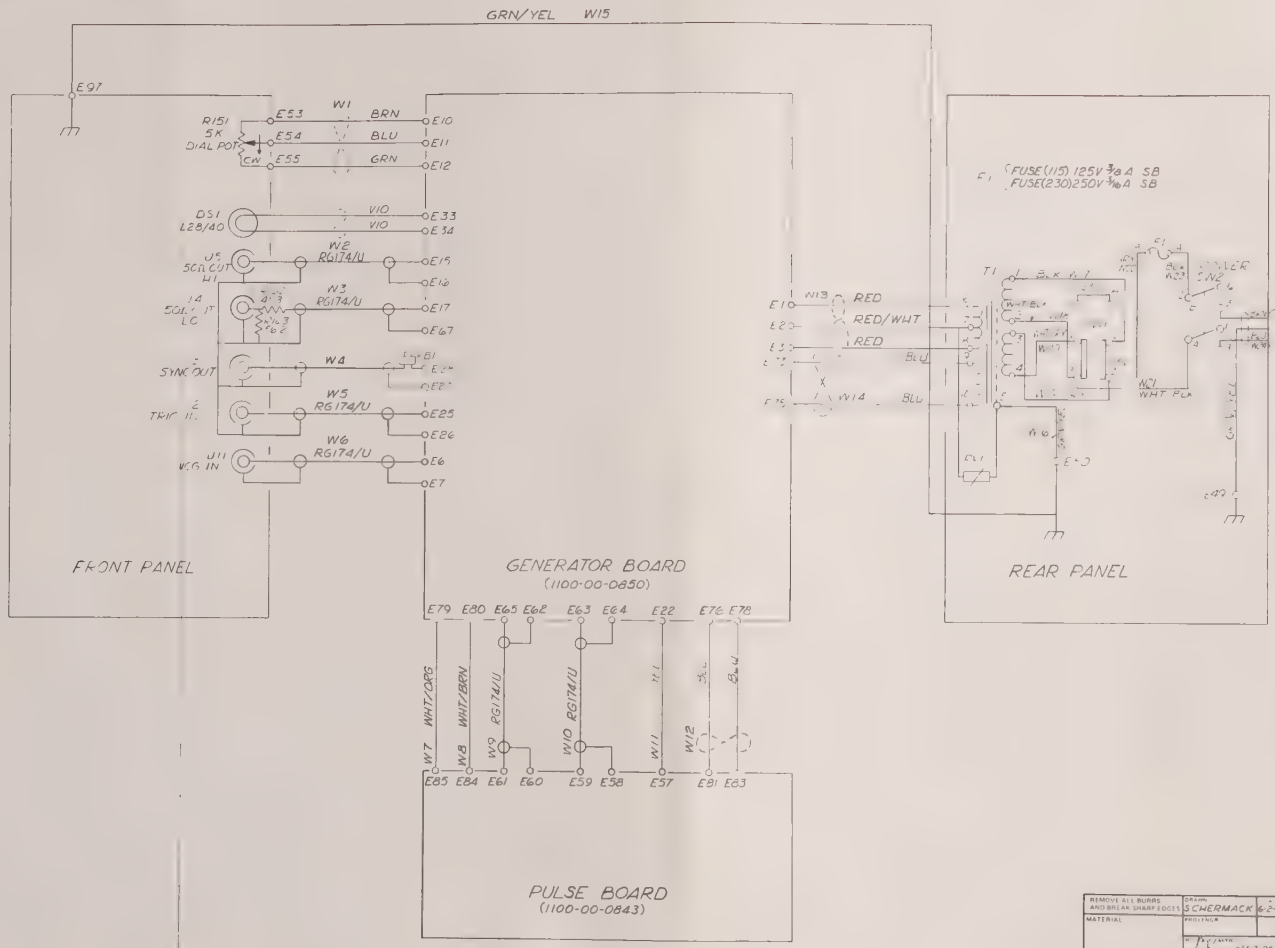

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN S CHERMACK 6-2-80	WAVETEK	
MATERIAL	PROJ ENGR		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XX .030 .XXX	SCHEMATIC INSTRUMENT	
	DO NOT SCALE DWG	MODEL NO 187	DWG NO 0004-00-0174
	SCALE	ZONE DEPT 23338	SHEET 1 OF 1

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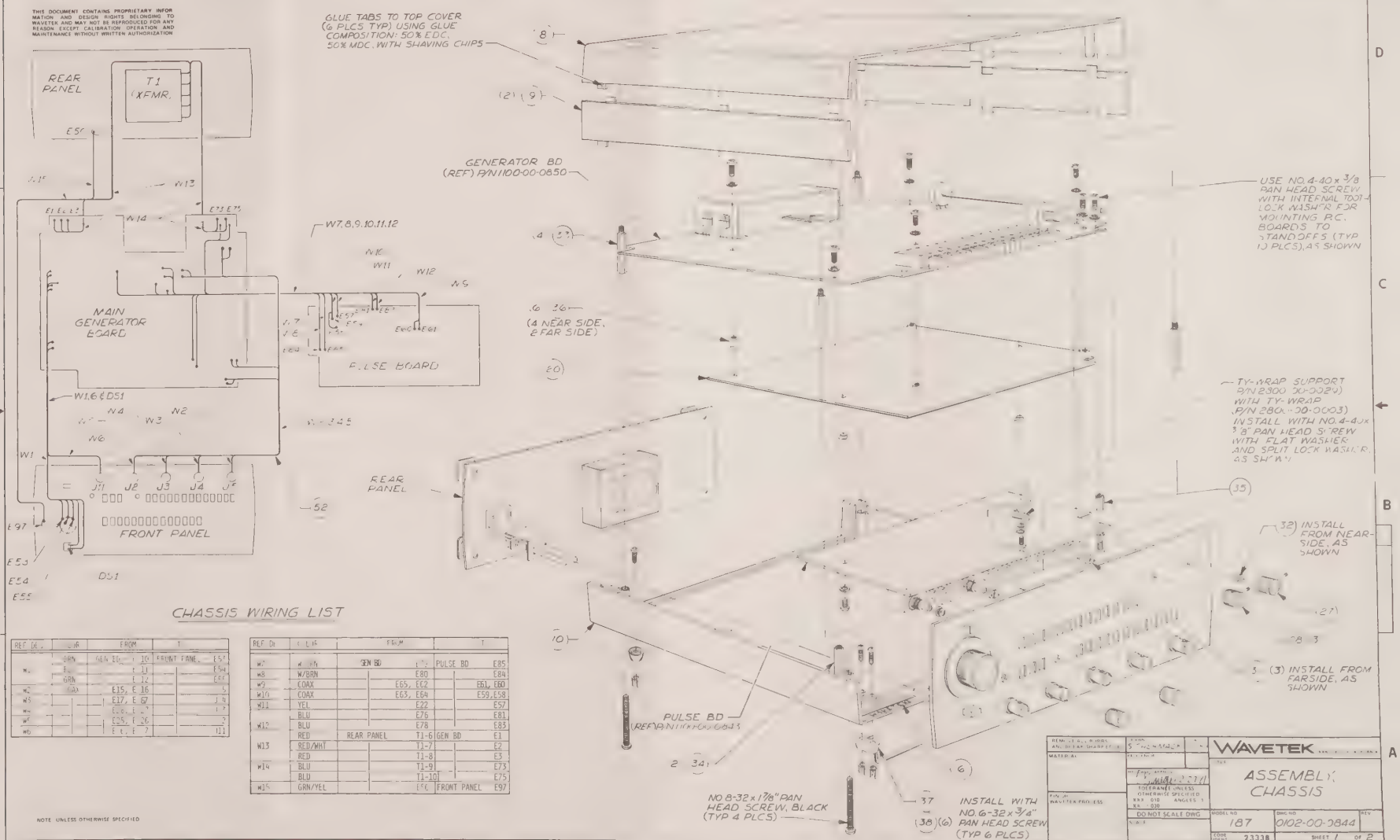

GLUE TABS TO TOP COVER (6 PLCS TYP) USING GLUE COMPOSITION: 50% EDC, 50% MDC, WITH SHAVING CHIPS
GENERATOR BD (REF) P/N 1100-00-0850
USE NO.4-40 x 3/8 PAN HEAD SCREW WITH INTERNAL TOOTH LOCK WASHER FOR MOUNTING P.C. BOARDS TO STANDOFFS (TYP 10 PLCS), AS SHOWN
(4 NEAR SIDE, 2 FAR SIDE)
TY-WRAP SUPPORT P/N 2300-00-0024) WITH TY-WRAP (P/N 2800-00-0003) INSTALL WITH NO.4-40 x 3/8" PAN HEAD SCREW WITH FLAT WASHER AND SPLIT LOCK WASHER, AS SHOWN
(32) INSTALL FROM NEAR-SIDE, AS SHOWN
(3) INSTALL FROM FARSIDE, AS SHOWN
PULSE BD (REF) P/N 1100-00-0843
NO.8-32 x 1/8" PAN HEAD SCREW, BLACK (TYP 4 PLCS)
(38)(6) INSTALL WITH NO.6-32 x 3/4" PAN HEAD SCREW (TYP 6 PLCS)
REAR PANEL
T1 (XFMR)
MAIN GENERATOR BOARD
PULSE BOARD
FRONT PANEL
W1,6 & DS1
W7,8,9,10,11,12
W13
W14
W1
W2
W3
W4
W5
W6
J1
J2
J3
J4
J5
DS1
E97
E53
E54
E55

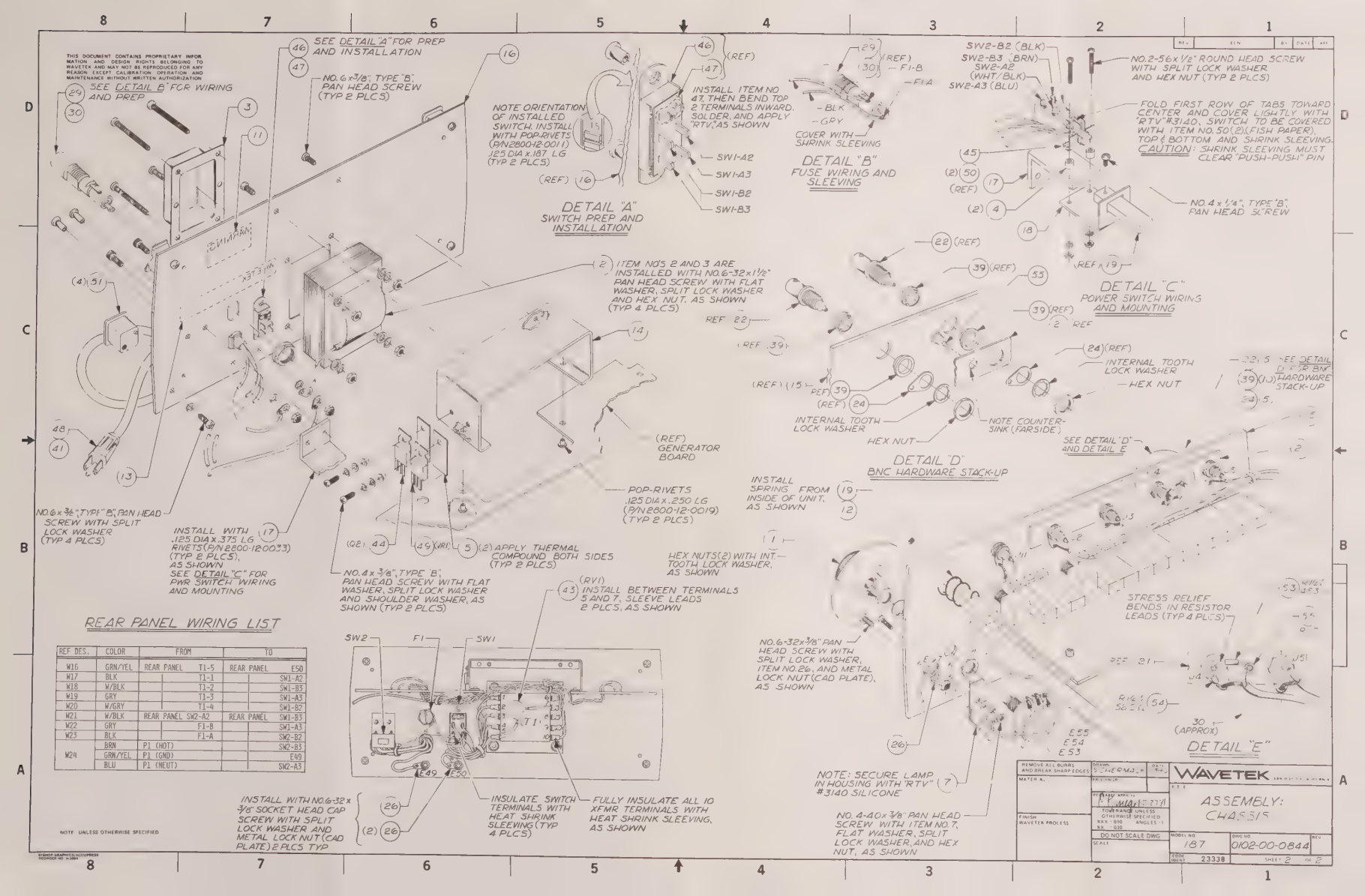
CHASSIS WIRING LIST

REF DE.	WIR	FROM	T
	GRN	GEN BD J6	FRONT PANEL E57
W2	B	J1	E84
	GRN	J2	E60
W6	BLU	E15, E16	E1
W5		E17, E67	J3
W4		E66, E67	J4
W3		E59, E58	J5
W1		E1, E7	J1

REF DE	WIR	FROM	T
W2	W/BRN	GEN BD J6	PULSE BD E85
W8	W/BRN	E80	E84
W9	COAX	E65, E62	E61, E60
W10	COAX	E63, E64	E59, E58
W11	YEL	E22	E57
	BLU	E76	E81
W12	BLU	E78	E83
	RED	REAR PANEL T1-6	GEN BD E1
W13	RED/WHT	T1-7	E2
	RED	T1-8	E3
W14	BLU	T1-9	E73
	BLU	T1-10	E75
W15	GRN/YEL	E96	FRONT PANEL E97

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	FINISH	WAVETEK	
MATERIAL		TITLE: ASSEMBLY, CHASSIS	
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX .010 ANGLES 1° .XX .030		
DO NOT SCALE DWG		MODEL NO. 187	DWG NO. 0102-00-0844 REV
		CODE IDENT 23338	SHEET 1 OF 2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SEE DETAIL "B" FOR WIRING AND PREP
SEE DETAIL "A" FOR PREP AND INSTALLATION
NO. 6 x 3/8", TYPE "B" PAN HEAD SCREW (TYP 2 PLCS)
NOTE ORIENTATION OF INSTALLED SWITCH. INSTALL WITH POP-RIVETS (P/N 2800-12-0011) .125 DIA x .187 LG (TYP 2 PLCS)
INSTALL ITEM NO 47, THEN BEND TOP 2 TERMINALS INWARD. SOLDER, AND APPLY "RTV" AS SHOWN
SW1-A2
SW1-A3
SW1-B2
SW1-B3
DETAIL "A" SWITCH PREP AND INSTALLATION
F1-B
F1-A
BLK
GRY
COVER WITH SHRINK SLEEVING
DETAIL "B" FUSE WIRING AND SLEEVING
SW2-B2 (BLK)
SW2-B3 (BRN)
SW2-A2 (WHT/BLK)
SW2-A3 (BLU)
NO. 2-56 x 1/2" ROUND HEAD SCREW WITH SPLIT LOCK WASHER AND HEX NUT (TYP 2 PLCS)
FOLD FIRST ROW OF TABS TOWARD CENTER AND COVER LIGHTLY WITH "RTV" #3140, SWITCH TO BE COVERED WITH ITEM NO. 50 (2) (FISH PAPER), TOP & BOTTOM AND SHRINK SLEEVING. CAUTION: SHRINK SLEEVING MUST CLEAR "PUSH-PUSH" PIN
NO. 4 x 1/4", TYPE "B" PAN HEAD SCREW
ITEM NO'S 2 AND 3 ARE INSTALLED WITH NO. 6-32 x 1 1/2" PAN HEAD SCREW WITH FLAT WASHER, SPLIT LOCK WASHER AND HEX NUT, AS SHOWN (TYP 4 PLCS)
DETAIL "C" POWER SWITCH WIRING AND MOUNTING
INTERNAL TOOTH LOCK WASHER
HEX NUT
NOTE COUNTER-SINK (FARSIDE)
SEE DETAIL "D" AND DETAIL E
(REF) GENERATOR BOARD
POP-RIVETS .125 DIA x .250 LG (P/N 2800-12-0019) (TYP 2 PLCS)
INSTALL SPRING FROM INSIDE OF UNIT, AS SHOWN
DETAIL "D" BNC HARDWARE STACK-UP
NO. 6 x 3/8", TYPE "B" PAN HEAD SCREW WITH SPLIT LOCK WASHER (TYP 4 PLCS)
INSTALL WITH .125 DIA x .375 LG RIVETS (P/N 2800-120033) (TYP 2 PLCS), AS SHOWN SEE DETAIL "C" FOR PWR SWITCH WIRING AND MOUNTING
NO. 4 x 3/8", TYPE "B" PAN HEAD SCREW WITH FLAT WASHER, SPLIT LOCK WASHER AND SHOULDER WASHER, AS SHOWN (TYP 2 PLCS)
(2) APPLY THERMAL COMPOUND BOTH SIDES (TYP 2 PLCS)
HEX NUTS (2) WITH INT.-TOOTH LOCK WASHER, AS SHOWN
(RV1) INSTALL BETWEEN TERMINALS 5 AND 7, SLEEVE LEADS 2 PLCS, AS SHOWN
STRESS RELIEF BENDS IN RESISTOR LEADS (TYP 4 PLCS)
NO. 6-32 x 3/8" PAN HEAD SCREW WITH SPLIT LOCK WASHER, ITEM NO. 26, AND METAL LOCK NUT (CAD PLATE), AS SHOWN
DETAIL "E"
NOTE: SECURE LAMP IN HOUSING WITH "RTV" #3140 SILICONE
NO. 4-40 x 3/8" PAN HEAD SCREW WITH ITEM NO. 7, FLAT WASHER, SPLIT LOCK WASHER, AND HEX NUT, AS SHOWN
INSTALL WITH NO. 6-32 x 3/8" SOCKET HEAD CAP SCREW WITH SPLIT LOCK WASHER AND METAL LOCK NUT (CAD PLATE) 2 PLCS TYP
INSULATE SWITCH TERMINALS WITH HEAT SHRINK SLEEVING (TYP 4 PLCS)
FULLY INSULATE ALL 10 XFMR TERMINALS WITH HEAT SHRINK SLEEVING, AS SHOWN
SW2
F1
SW1
T1
E49
E50
E55
E54
E53
NOTE UNLESS OTHERWISE SPECIFIED
WAVETEK
ASSEMBLY: CHASSIS
MODEL NO 187
DWG NO 0102-00-0844
REV
SHEET 2 OF 2

REAR PANEL WIRING LIST

REF DES.	COLOR	FROM		TO	
W16	GRN/YEL	REAR PANEL	T1-5	REAR PANEL	E50
W17	BLK		T1-1		SW1-A2
W18	W/BLK		T1-2		SW1-B3
W19	GRY		T1-3		SW1-A3
W20	W/GRY		T1-4		SW1-B2
W21	W/BLK	REAR PANEL SW2-A2		REAR PANEL	SW1-B3
W22	GRY		F1-B		SW1-A3
W23	BLK		F1-A		SW2-B2
W24	BRN	P1 (HOT)			SW2-B3
	GRN/YEL	P1 (GND)			E49
	BLU	P1 (NEUT)			SW2-A3

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REV	E.N	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
NONE	ASSY DRWG. CHASSIS	N		0102-00	0102-00-0844	.
.	DIAL ASSY	182A-0028	WVTK	1201-00-0028	1
A	TRANSFORMER	5600-00-0025	WVTK	1204-00-0046	1
[illegible]	CHASSIS CABLE KIT	187-0877	WVTK	1207-00-0877	1
[illegible]	END BELL	110-333	WVTK	1400-00-0174	1
[illegible]	SPACER	8480	WVTK	1400-00-0653	2
[illegible]	INSULATOR MICA	[illegible]	[illegible]	[illegible]	.
6	PLATE NAME	[illegible]	[illegible]	[illegible]	.
[illegible]	INDICATOR DIAL	[illegible]	[illegible]	[illegible]	.
[illegible]	COVER. TOP	180-300-1	WVTK	1400-00-5000	1
[illegible]	EXPANDER	180-301	WVTK	1400-00-5010	4
[illegible]	POST	180-302	WVTK	1400-00-5023	4
11	COVER BOTTOM	180-300-2	WVTK	1400-00-5030	1
[illegible]	LABEL WARNING	1400-00-6940	WVTK	1400-00-6940	.
[illegible]	SPRING POWER ROD REF 3200-01 0001	1400-00-8280	[illegible]	[illegible]	.
[illegible]	INSULATOR PWR SWITCH REF 1400-99 0701	1400-00-8277	[illegible]	[illegible]	2
[illegible]	[illegible]	[illegible]	[illegible]	1400-00-9110	.

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	[illegible]
32	SWING CYLINDER-1 B	2L2FF	THOMA
33	STANDOFF, MALE/FEMALE .750 H, .250 HEX 6-32	1475-M03-F05-832	
34	STANDOFF MALE/FEMALE 2.50H .250 HEX 4-40	1499-M03-F03-440	UNICP
35	STANDOFF .625H, .250 HEX 4-40	8835	SMITH
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
38	SPEEDNUT SELF RETAIN	C7494-632-4	
[illegible]	NUMER SHOULDER	2666	
[illegible]	STRAIN RELIEF BUSH	SR6W-1	
[illegible]	[illegible] MF, 1 6W 1%, 45Ω	RN55[illegible]4530	
[illegible]	[illegible] 5Ω, 2	RN55[illegible]8R2F	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	

WAVETEK PARTS LIST | TITLE | ASSEMBLY NO. 5644 | REV B

WAVETEK PARTS LIST | TITLE CHASSIS | ASSEMBLY NO. 1101-00-0844 | PAGE 3 | REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
[illegible]	BRACKET AC SHIELD	1400-30-8473	WVTK	1400-00-8473	1
[illegible]	PANEL FRONT	1400-01-1900	WVTK	1400-01-1900	1
[illegible]	PANEL REAR	1400-01-3253	WVTK	1400-01-3253	1
[illegible]	BRACKET SWITCH MTG	1400-01-3263	WVTK	1400-01-3263	1
[illegible]	BRACKET POWER POD	1400-01-3273	WVTK	1400-01-3273	.
2	POWER POD	1400-01-3280	WVTK	1400-01-3280	.
3	SHIELD PLATE	1400-01-3293	WVTK	1400-01-3293	.
4	GROUNDING PLATE	1400-01-3303	WVTK	1400-01-3303	.
4	BNC CONN	MC-7946	KING	2100-01-0002	.
4	SOLDER LUG	1492	SMITH	2100-04-0012	.
4	SOLDER LUG	1483-6	SMITH	2100-04-0045	.
[illegible]	TERMINAL INSULATED	014-2001-00-0-476	SLTRO	2130-05-0054	.
[illegible]	KNOB, SMALL	.-M-9	ROGAN	2400-01-0010	.
[illegible]	KNOB 1/4IN BUSHING	RB-6? 0-M-9	ROGAN	2400-01-0017	.
29	FUSE 3/8A 250V, S-B	313.375	LITFU	2400-05-0009	1
30	FUSE HOLD	031.1653/031.1000	SCHUR	2400-05-0012	.
31	BUSHING NYLINER	4L2FF	THOMA	2800-01-0002	.

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG MFGR-PART-NO	[illegible]
46	SWITCH ASSY SLIDE	[illegible]	[illegible]
47	SOLDER GUARD	[illegible]	[illegible]
48	PWR CORD	G-3789-008-C6	PACRD	6001-01-0004
49	VOLTAGE REGULATOR	MC7815	MOT	7800-70-1500
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

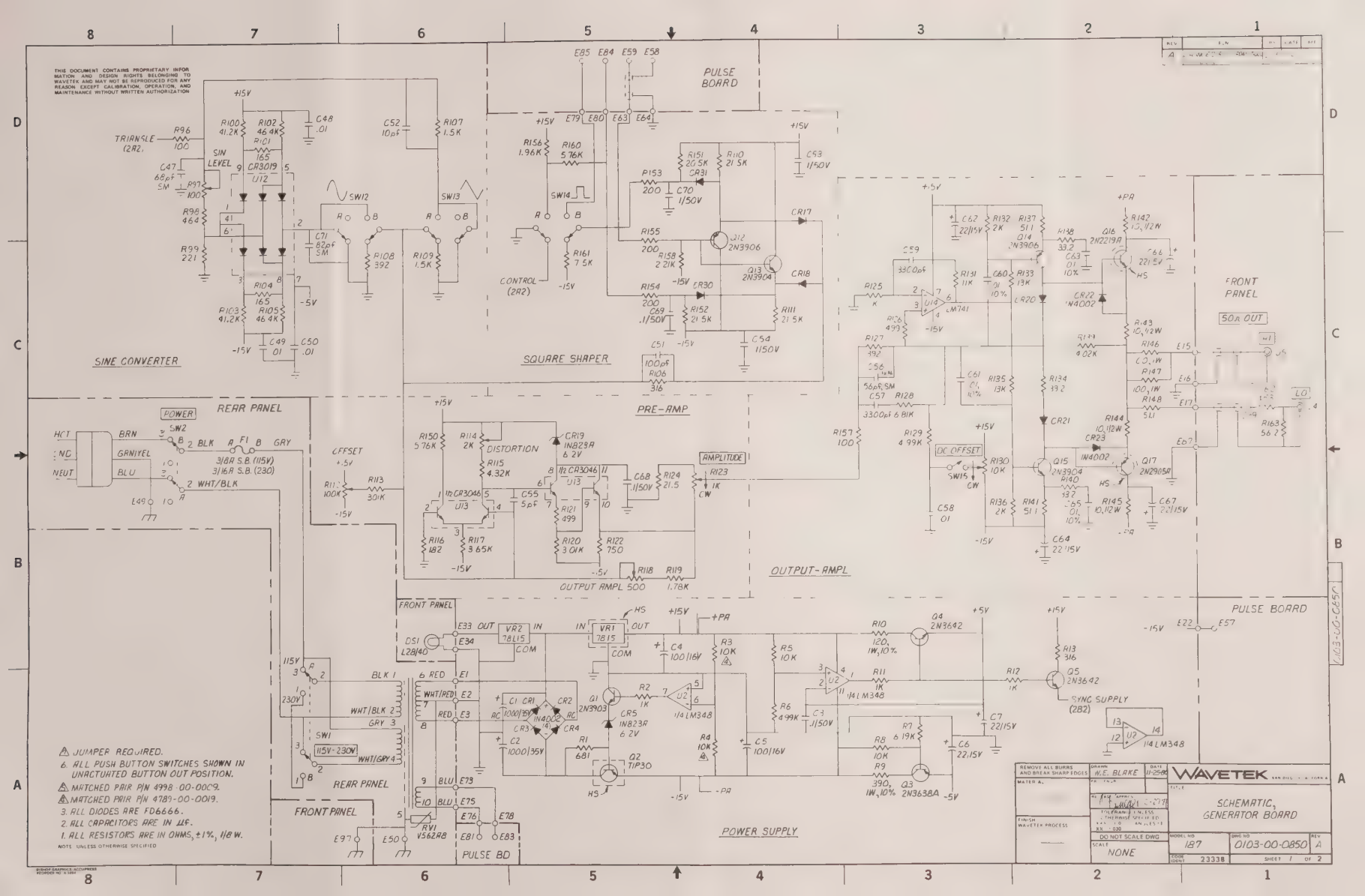
WAVETEK PARTS LIST | TITLE CHASSIS | ASSEMBLY NO. 1101-00-0844 | PAGE 2 | REV B

WAVETEK PARTS LIST | TITLE CHASSIS | ASSEMBLY NO. 1101-00-0844 | PAGE - | REV -

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROJ ENGR		TITLE PARTS LIST CHASSIS
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ±.010 ANGLES ±1° XX ±.020		
	DO NOT SCALE DWG		MODEL NO. 187 / DWG NO. 1101-00-0844 / REV B
	SCALE		CODE IDENT 23338 / SHEET 1 OF 1

BISHOP GRAPHICS/ACCUPRESS REORDER NO. A-3894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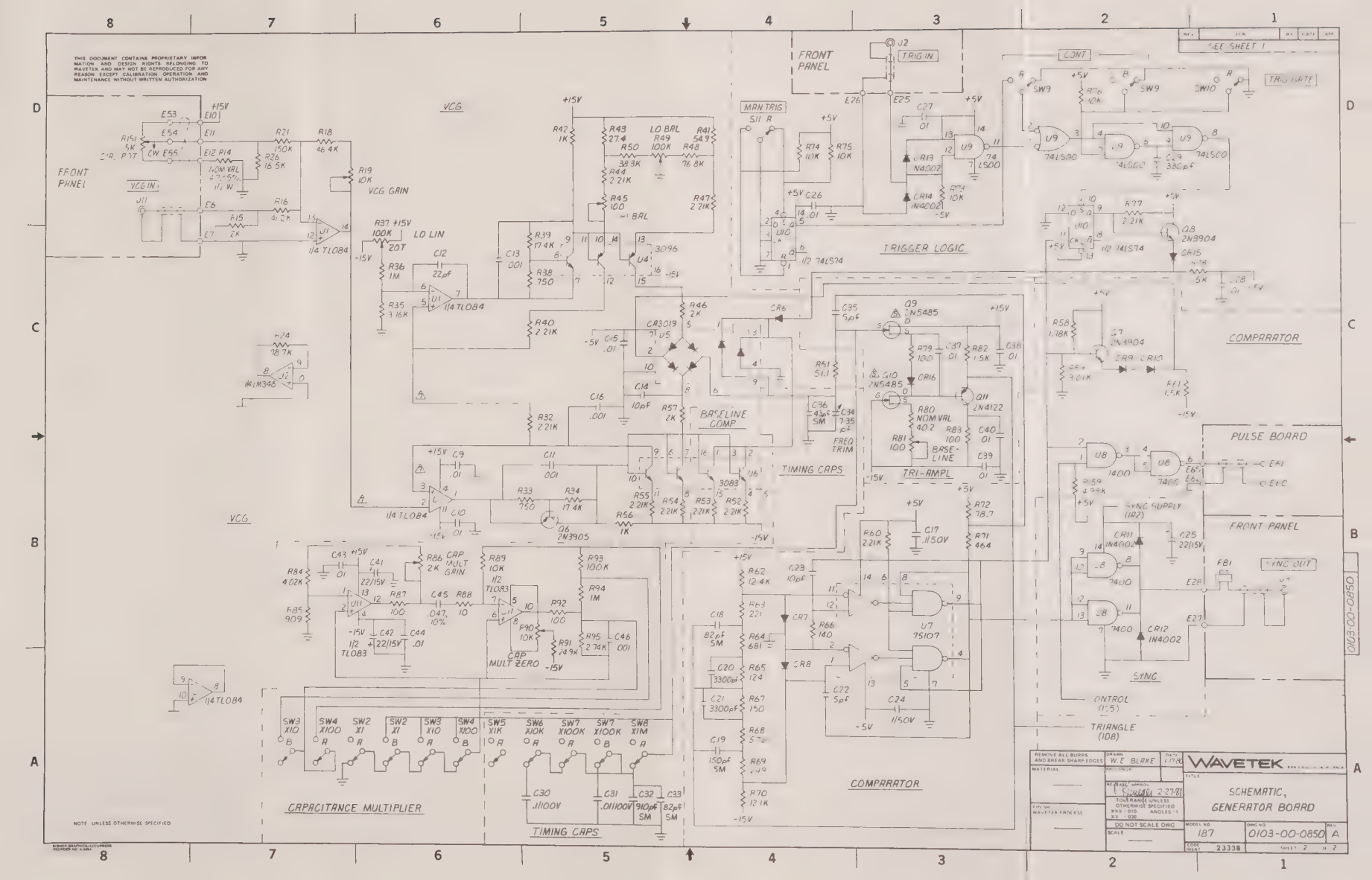
SINE CONVERTER
SQUARE SHAPER
PULSE BOARD
PRE-AMP
OUTPUT-AMPL
POWER SUPPLY
REAR PANEL
FRONT PANEL
TRIANGLE (2R2)
CONTROL (2R2)
SYNC SUPPLY (2B2)
50Ω OUT
DC OFFSET
AMPLITUDE
DISTORTION
OUTPUT AMPL 500
SCHEMATIC, GENERATOR BOARD
WAVETEK
MODEL NO 187
DWG NO 0103-00-0850
REV A
SHEET 1 OF 2
SCALE NONE
CODE IDENT 23338
DRAWN W.E. BLAKE
DATE 11-25-80
DO NOT SCALE DWG
1. ALL RESISTORS ARE IN OHMS, ±1%, 1/8 W.
2. ALL CAPACITORS ARE IN μF.
3. ALL DIODES ARE FD6666.
4. MATCHED PAIR P/N 4998-00-0009.
5. MATCHED PAIR P/N 4789-00-0019.
6. ALL PUSH BUTTON SWITCHES SHOWN IN UNACTUATED BUTTON OUT POSITION.
JUMPER REQUIRED.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SEE SHEET 1
FRONT PANEL
TRIG IN
J2
E26
E25
CONT
TRIG RATE
MAN TRIG
S11
TRIGGER LOGIC
VCG
VCG GAIN
VCG IN
LO BAL
HI BAL
LO LIN
BASELINE COMP
TIMING CAPS
FREQ TRIM
TRI-AMPL
BASE-LINE
COMPARATOR
PULSE BOARD
SYNC SUPPLY (1A2)
SYNC OUT
SYNC
CONTROL (1A5)
TRIANGLE (1D8)
CAPACITANCE MULTIPLIER
CAP MULT GAIN
CAP MULT ZERO
SW3 X10
SW4 X100
SW2 X1
SW2 X1
SW3 X10
SW4 X100
SW5 X1K
SW6 X10K
SW7 X100K
SW7 X100K
SW8 X1M
NOTE UNLESS OTHERWISE SPECIFIED
WAVETEK
SCHEMATIC, GENERATOR BOARD
MODEL NO 187
DWG NO 0103-00-0850
REV A
SHEET 2 OF 2
0103-00-0850

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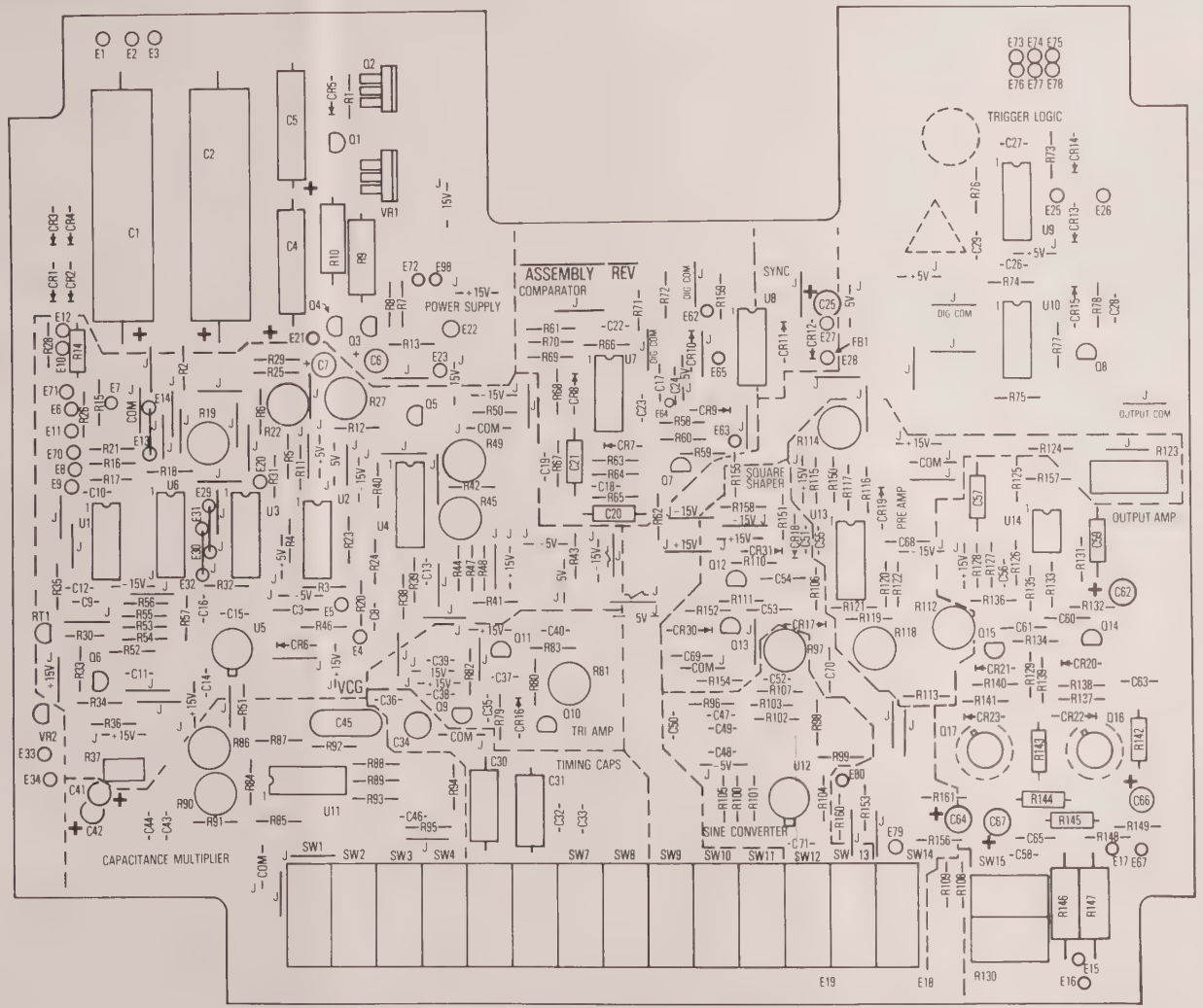

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CALIFORNIA
MATL'S &	TECHNICIAN		GENERATOR BD
FINISH WAVETEK PROJECT	MECHANICAL APPROVAL		
	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON ANGLES ±		
	UNLESS SCALE EQ WG		MODEL NO. 187 — DWG NO. 1100-00-0850 — REV
			CODE IDENT. 23338 — SHEET 1 OF 1

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REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG MFGR-PART NO	MFGR	WAVETEK NO.	QTY/ASY
NONE	ASSY DRWG, GENERATOR	0101-00-0850	WVTK	0101-00-0850	1
NONE	SCHEMATIC, GENERATOR	0103-00-0850	WVTK	0103-00-0850	1
C22 C35 C55	CAP. CER. 5PF, 1KV	DD-050	CRL	1500-00-5011	3
C14 C23 C32	CAP. CER. 10PF, 1KV	DD-100	CRL	1500-01-0011	3
C51	CAP. CER. 100PF, 1KV	DD-101	CRL	1500-01-0111	1
[illegible] C16 C46	CAP. CER. .001MF, 1KV	DD-102	ARCO	1500-01-0211	4
[illegible] C26 C27 C28 C39 C40 C43 [illegible] C49 C50 C58	CAP. CER. .01MF, 50V	CK-103	CRL	1500-01-0310	16
C60 C61 C63 C65	CAP. CER. MN. .01MF, 50V	18011R050A103K	VARDN	1500-01-0323	4
C17 C24 C3 C53 C54 C66 C69 C70	CAP. CER. MON. .1MF, 50V	18022S050A104Z	VARDN	1500-01-0405	8
C12	CAP. CER. 22PF, 1KV	DD-220	ARCO	1500-02-2011	1
C29	CAP. CER. 330PF 1KV	DD-331	ARCO	1500-03-3111	1
C20 C21 C37 C59	CAP. C. MN. 3300PF, 50V	18011R050A332J	VRDYN	1500-03-3205	4
C19	CAP. MICA. 150PF, 500V	DM15-151J	ARCO	1500-11-5100	1
C36	CAP MICA. 43PF 500V	DM15-430J	ARCO	1500-14-3000	1
C5oT	CAP MICA. 56PF, 500V	DM15-560J	ARCO	1500-15-6000	1
C47	CAP. MICA. 68PF 500V	DM15-680J	ARCO	1500-16-8000	1

WAVETEK PARTS LIST | TITLE PCA. GENERATOR BD | ASSEMBLY NO. 1100-00-0850 | PAGE 1 | REV C

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG MFGR PART NO	MFGR	WAVETEK NO	QTY/ASY
R114 R86	POT. TRIM. 2K	91AR2K	BECK	4600-02-0201	2
R118	POT. TRIM. 500	91AR500	BECK	4600-05-0104	1
R130	POT. SWITCH. 10K	GH-1879	CTS	4602-01-0300	1
R123	POT. CONT. 1K FROM 4600-01-0207	4609-71-0201	WVTK	4609-71-0201	1
R37	POT. TRIM. 20T. 100K	68WR100K	BECK	4609-90-0001	1
R142 R143 R144 R145	RES. C. 1/2W. 5%. 10	RC20GF-100	STKPL	4700-25-0100	4
R14	RES. C. 1/2W. 5%. 4.7	RC20GF-4R7	STKPL	4700-25-0479	1
R10	RES. C. 1W. 10%. 120	RC32F-121K	AB	4700-36-1200	1
R9	RES. C. 1W. 10%. 390	RC32GF391K	AB	4700-36-3900	1
R137 R79 R83 R87 R92 R96	RES. MF. 1/8W. 1%. 100	RN55D-1000F	TRW	4701-03-1000	6
R11 R12 R128 R2 R42 R36	RES. MF. 1/8W. 1%. 1K	RN55D-1001F	TRW	4701-03-1001	6
R3 R73 R74 R75 R76 R8 R89	RES. MF. 1/8W. 1%. 10K	RN55D-1002F	TRW	4701-03-1002	7
R93	RES. MF. 1/8W. 1%. 100K	RN55D-1003F	TRW	4701-03-1003	1
R36 R94	RES. MF. 1/8W. 1%. 1M	RN55D-1004F	TRW	4701-03-1004	2
R88	RES. MF. 1/8W. 1%. 10	RN55D-10R0F	TRW	4701-03-1009	1

WAVETEK PARTS LIST | TITLE PCA. GENERATOR BD | ASSEMBLY NO. 1100-00-0850 | PAGE 3 | REV C

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG MFGR PART NO	MFGR	WAVETEK NO	QTY/ASY
R151	RES. MF 1/8W. 1%. 20.5K	RN55D-2052F	TRW	4701-03-2052	1
R110 R111 R132	RES. MF 1/8W. 1%. 21.5K	RN55D-2152F	TRW	4701-03-2152	3
R124	RES. MF 1/8W. 1%. 21.5	RN55D-21R5F	TRW	4701-03-2159	1
R63 R99	RES. MF 1/8W. 1%. 221	RN55D-2210F	TRW	4701-03-2210	2
R138 R32 R40 R44 R47 R52 R53 R54 R55 R60 R77	RES. MF 1/8W. 1%. 2.21K	RN55D-2211F	TRW	4701-03-2211	11
R69	RES. MF 1/8W. 1%. 249	RN55D-2490F	TRW	4701-03-2490	1
R91	RES. MF 1/8W. 1%. 24.9K	RN55D-2492F	TRW	4701-03-2492	1
R95	RES. MF 1/8W. 1%. 2.74K	RN55D-2741F	TRW	4701-03-2741	1
R43	RES. MF 1/8W. 1%. 27.4	RN55D-27R4F	TRW	4701-03-2740	1
R120 R59	RES. MF 1/8W. 1%. 3.01K	RN55D-3011F	TRW	4701-03-3011	2
R113	RES. MF 1/8W. 1% 301K	RN55D-3013F	TRW	4701-03-3013	1
R106 R13	RES. MF 1/8W. 1%. 31.6	RN55D-31R6F	TRW	4701-03-3160	2
R35	RES. MF 1/8W. 1%. 3.16K	RN55D-3161F	TRW	4701-03-3161	1
R134 R138 R140	RES. MF 1/8W 1% 33.2	RN55D-33R2F	TRW	4701-03-3320	3
R117	RES. MF 1/8W. 1%. 3.65K	RN55D-3651F	TRW	4701-03-3651	1
R50	RES MF 1 8W. 1% 38.3K	RN55D-3832F	TRW	4701-03-3832	1

WAVETEK PARTS LIST | TITLE [illegible] | ASSEMBLY NO [illegible] | REV

REFERENCE DESIGNATOR	PART DESCRIPTION	ORIG MFGR-PART NO	MFGR	WAVETEK NO.	QTY/ASY
C18 C33T C71	CAP. MICA. 82PF, 500V	DM15-820J	ARCO	1500-18-2000	3
C32	CAP 910PF. 100V. 1%	DM13-911F	ARCO	1500-19-1101	1
C4 C5	CAP. ELECT. 100MF. 16V	500D107G016DC7	SPRAG	1500-31-0101	2
C1 C2	CAP. ELECT. 1000MF. 35V	39D10800350L6	SPRAG	1500-31-0212	2
C31	CAP. POLYC. .01MF. 100V	PA28103F	ELCUB	1500-41-0304	1
C30	CAP. POLYC. .1MF. 100V	PA28104F	ELCUB	1500-41-0404	1
C45	CAP. MYLAR. .047MF100V	225P47391WD3	SPRAG	1500-44-7314	1
C34	VAR1. 7-35PF. 250V	75-TR1A0-02 7/35 PF	TRIKO	1500-53-5000	1
C25 C41 C42 C6 C62 C64 C65 C67 C7	CAP. TANT. 22MF. 15V	196D226X9015KA1	SPRAG	1500-72-2601	9
NONE	GENERATOR BOARD	1700-00-0850	WVTK	1700-00-0850	1
DS1	LAMP	L28/40	MURA	2400-02-0017	1
NONE	HEAT SINK	NF-207	WAKE	2800-11-0001	2
NONE	TRANSIPAD	10160	METRS	2800-11-0004	2
FB1	FERRITE BEAD	56-590-65/3B	FERRX	3100-00-0001	1
R45 R81 R97	POT. TRIM. 100	91AR100	BECK	4600-01-0103	3
R19 R90	POT. TRIM. 10K	91AR10K	BECK	4600-01-0313	2
R112 R49	POT. TRIM. 100K	91AR100K	BECK	4600-01-0402	2

WAVETEK PARTS LIST | TITLE PCA. GENERATOR BD | ASSEMBLY NO [illegible] | PAGE 2 | REV C

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG MFGR PART NO	MFGR	WAVETEK NO	QTY/ASY
R131	RES. MF. 1/8W. 1%. 11K	RN55D-1102F	TRW	4701-03-1102	1
R70	RES. MF. 1/8W. 1%. 12.1K	RN55D-1212F	TRW	4701-03-1212	1
R65	RES. MF. 1/8W. 1%. 124	RN55D-1240F	TRW	4701-03-1240	1
R62	RES. MF. 1/8W. 1%. 12.4K	RN55D-1242F	TRW	4701-03-1242	1
R133 R135	RES. MF. 1/8W. 1%. 13K	RN55D-1302F	TRW	4701-03-1302	2
R66	RES. MF. 1/8W. 1%. 140	RN55D-1400F	TRW	4701-03-1400	1
R67	RES. MF. 1/8W. 1%. 150	RN55D-1500F	TRW	4701-03-1500	1
R107 R109 R61 R78 R82	RES. MF. 1/8W. 1%. 1.5K	RN55D-1501F	TRW	4701-03-1501	5
R21	RES. MF. 1/8W. 1%. 150K	RN55D-1503F	TRW	4701-03-1503	1
R101 R104	RES. MF. 1/8W. 1%. 165	RN55D-1650F	TRW	4701-03-1650	2
R26	RES. MF. 1/8W. 1%. 16.5K	RN55D-1652F	TRW	4701-03-1652	1
R34 R39	RES. MF. 1/8W. 1%. 17.4K	RN55D-1742F	TRW	4701-03-1742	2
R119 R98	RES. MF. 1/8W. 1%. 1.78K	RN55D-1781F	TRW	4701-03-1781	2
R116	RES. MF. 1/8W. 1%. 182	RN55D-1820F	TRW	4701-03-1820	1
R136	RES. MF. 1/8W. 1%. 1.96K	RN55D-1961F	TRW	4701-03-1961	1
R153 R154 R155	RES. MF. 1/8W. 1%. 200	RN55D-2000F	TRW	4701-03-2000	3
R132 R136 R15 R46 R57	RES. MF. 1/8W. 1%. 2K	RN55D-2001F	TRW	4701-03-2001	5

WAVETEK PARTS LIST | TITLE PCA. GENERATOR BD | ASSEMBLY NO. 1100-00-0850 | PAGE 4 | REV C

REFERENCE DESIGNATOR	PART DESCRIPTION	ORIG MFGR PART NO	MFGR	WAVETEK NO	QTY/ASY
R108 R127	RES. MF 1/8W. 1%. 392	RN55D-3920F	TRW	4701-03-3920	2
R139 R84	RES. MF 1/8W. 1% 4.02K	RN55D-4021F	TRW	4701-03-4021	2
R80T	RES. MF 1/8W. 1%. 40.2	RN55D-40R2F	TRW	4701-03-4029	1
R100 R103 R16	RES. MF 1/8W. 1% 41.2K	RN55D-4122F	TRW	4701-03-4122	3
R115	RES. MF 1/8W. 1%. 4.32K	RN55D-4321F	TRW	4701-03-4321	1
R71 R98	RES. MF 1/8W. 1%. 464	RN55D-4640F	TRW	4701-03-4640	2
R102 R105 R18	RES. MF 1/8W. 1%. 46.4K	RN55D-4642F	TRW	4701-03-4642	3
R121 R126	RES. MF 1/8. 1%. 499	RN55D-4990F	TRW	4701-03-4990	2
R129 R159 R6	RES. MF 1/8W. 1%. 4.99K	RN55D-4991F	TRW	4701-03-4991	3
R137 R141 R148 R51	RES. MF 1/8W. 1%. 51.1	RN55D-51R1F	TRW	4701-03-5119	4
R41	RES. MF 1/8W. 1%. 54.9	RN55D-54R9F	TRW	4701-03-5499	1
R60	RES. MF 1/8W. 1%. 576	RN55D-5760F	TRW	4701-03-5760	1
R130 R160	RES. MF 1/8W. 1%. 5.76K	RN55D-5761F	TRW	4701-03-5761	2
R7	RES. MF 1/8W. 1%. 6.19K	RN55D-6191F	TRW	4701-03-6191	1
R1 R64	RES. MF 1/8W. 1%. 681	RN55D-6810F	TRW	4701-03-6810	2
R128	RES. MF 1/8W. 1%. 6.81K	RN55D-6811F	TRW	4701-03-6811	1
R122 R33 R38	RES. MF. 1/8W. 1%. 750	RN55D-7500F	TRW	4701-03-7500	3

WAVETEK PARTS LIST | TITLE PCA. GENERATOR BD | ASSEMBLY NO [illegible] | PAGE 6 | REV

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES | MATERIAL | FINISH WAVETEK PROCESS | DRAWN | DATE | PROJECTION | RELEASE APPROV | TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ± .010 ANGLES ± 1° .XX ± .030 | DO NOT SCALE DWG | SCALE

WAVETEK SAN DIEGO, CALIFORNIA

TITLE: PARTS LIST GENERATOR BD

MODEL NO. 187 | DWG NO. 1100-00-0850 | REV C | CODE IDENT 23338 | SHEET 1 OF 6

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REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
R161	RES. MF 1/8W. 1%. 7.5K	RN550-7501F	TRW	4701-03-7501	1
R48	RES. MF. 1/8W. 1%. 76.8K	RN550-7682F	TRW	4701-03-7682	1
R24	RES. MF. 1/8W. 1%. 78.7K	RN550-7872F	TRW	4701 03-7872	1
R72	RES. MF. 1/8W. 1%. 78.7	RN550-78R7F	TRW	4701-03-7879	1
R85	RES. MF. 1/8W. 1%. 909	RN550-9090F	TRW	4701-03-9090	1
R146 R147	RES MF. 1W. 1% 100	RN70B-1000F	TRW	4701-33-1000	2
R3 R4	RES SET. 2-10K. 1/8W QTY 2 4701-03-1002	142-501-64A	WVTK	4789-00-0019	1
CR19 CR5	DIODE ZENER 6.2V	1N823A	NPC	4801 01-0823	2
CR1 CR11 CR12 CR13 CR14 CR2 CR22 CR23 CR3 CR4	DIODE	SCE-1	SEMT	4801-02-0001	1
CR10 CR15 CR16 CR17 CR18 CR20 CR21 CR30 CR31 CR6 CR7 CR8 CR9	DIODE	FD-6666	FAIR	4807-02-6666	1
Q16	TRANS	2N2219A	NSC	4901-02-2191	1
Q17	TRANS	2N2905A	NSC	4901-02-9051	1
Q3	TRANS	2N3638A	CAPTR	4901-03-6381	1
Q4 Q5	TRANS	2N3642	FAIR	4901-33-6420	2
Q1	TRANS	2N3963	NS	4901 03-9030	1

WAVETEK PARTS LIST | TITLE PCA GENERATOR BD | ASSEMBLY NO 1100-00-0850 | PAGE 7 | REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
Q13 Q15 Q7 Q8	TRANS	2N3904	[illegible]	[illegible]	4
Q6	TRANS	2N3905	[illegible]	[illegible]	1
Q12 Q14	TRANS	2N3906	[illegible]	[illegible]	2
Q11	TRANS	2N4122	[illegible]	[illegible]	1
Q10 Q9	TRANS MFR 2N5485 QTY 2 4901-05-4850	142-501-53	WVTK	4998 50-0009	1
NONE	SWITCH ASS'Y PB	5103-00-0039	[illegible]	[illegible]	[illegible]
U11	[illegible]	TL083CN	[illegible]	[illegible]	[illegible]
U1	[illegible]	TL084CN	[illegible]	[illegible]	[illegible]
U2	[illegible]	LM348N	[illegible]	[illegible]	[illegible]
U14	[illegible]	MA-741	[illegible]	[illegible]	[illegible]
U10 U7	[illegible]	CA-3019	[illegible]	[illegible]	[illegible]
U13	[illegible]	CA-3046	[illegible]	[illegible]	[illegible]
U6	[illegible]	CA3089	[illegible]	[illegible]	1
U4	[illegible]	CA-3096A	[illegible]	[illegible]	[illegible]
U12	[illegible]	78L15	[illegible]	[illegible]	[illegible]
U7	[illegible]	SN75107AN	[illegible]	[illegible]	[illegible]
U8	[illegible]	7400	[illegible]	[illegible]	[illegible]

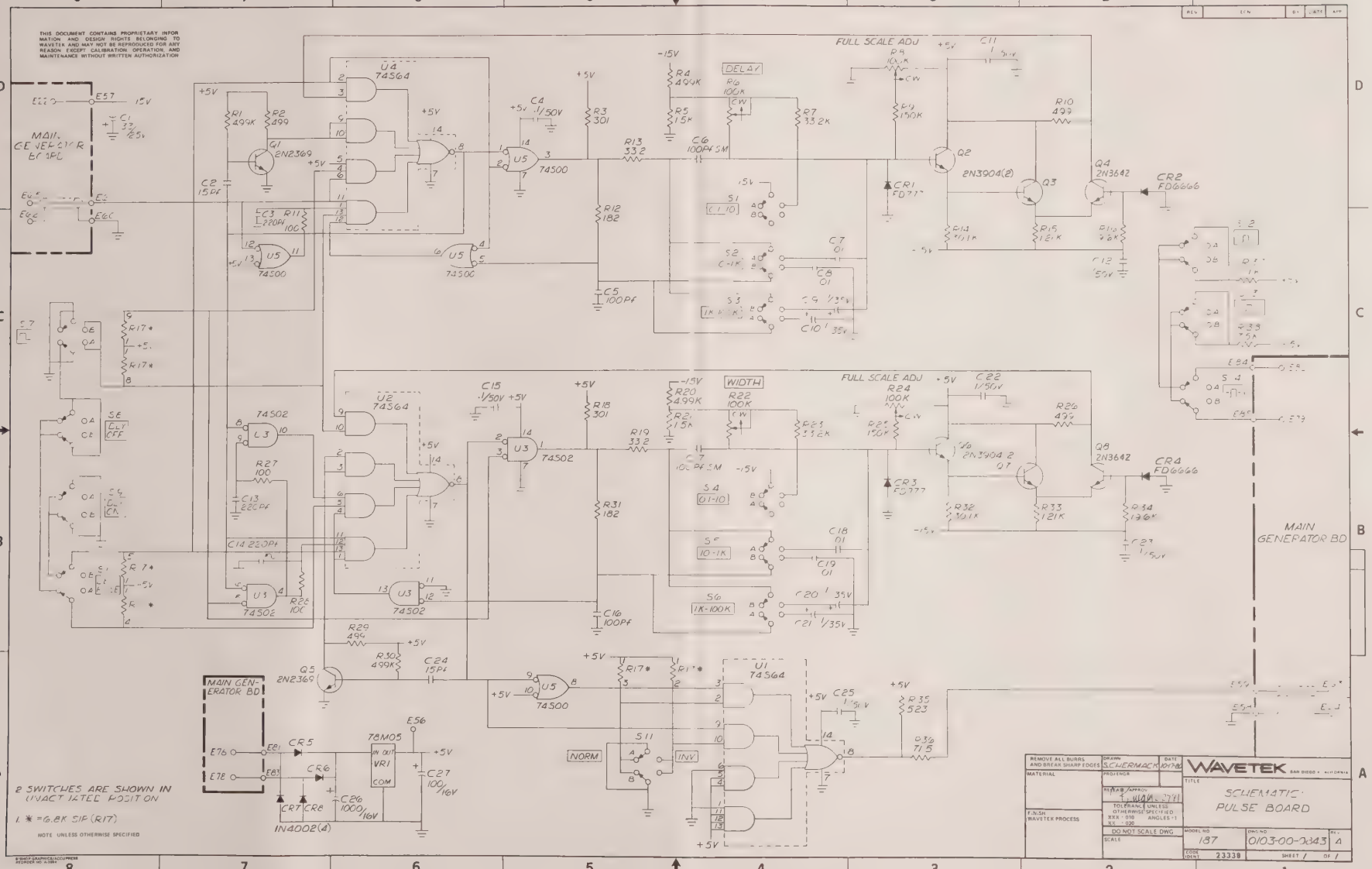
WAVETEK PARTS LIST | TITLE PCA GENERATOR BD | ASSEMBLY NO [illegible]-0850 | PAGE [illegible] | REV

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
U9	[illegible]	74LS00	[illegible]	[illegible]	[illegible]
U1	[illegible]	74LS74	[illegible]	[illegible]	[illegible]

WAVETEK PARTS LIST | TITLE PCA GENERATOR BD | ASSEMBLY NO 1100-00-0850 | PAGE 9 | REV

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROTENCER		TITLE PARTS LIST GENERATOR BD
FINISH WAVETEK PROCESS	RELEASE APPROV		
	TOLERANCE UNLESS OTHERWISE SPECIFIED XX ± .010 ANGLES 1 XX ± .030		
	DO NOT SCALE DWG	MODEL NO 187	DWG NO 1100-00-0850 REV C
	SCALE	CODE IDENT 23338	SHEET 2 OF 2

NOTE UNLESS OTHERWISE SPECIFIED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MAIN GENERATOR BD
FULL SCALE ADJ
DELAY
WIDTH
NORM
INV
2 SWITCHES ARE SHOWN IN INACTIVE POSITION
1 * = 6.8K SIP (R17)
NOTE UNLESS OTHERWISE SPECIFIED
IN4002(4)
WAVETEK
SCHEMATIC PULSE BOARD
MODEL NO 187
DWG NO 0103-00-2343
REV A
SHEET 1 OF 1

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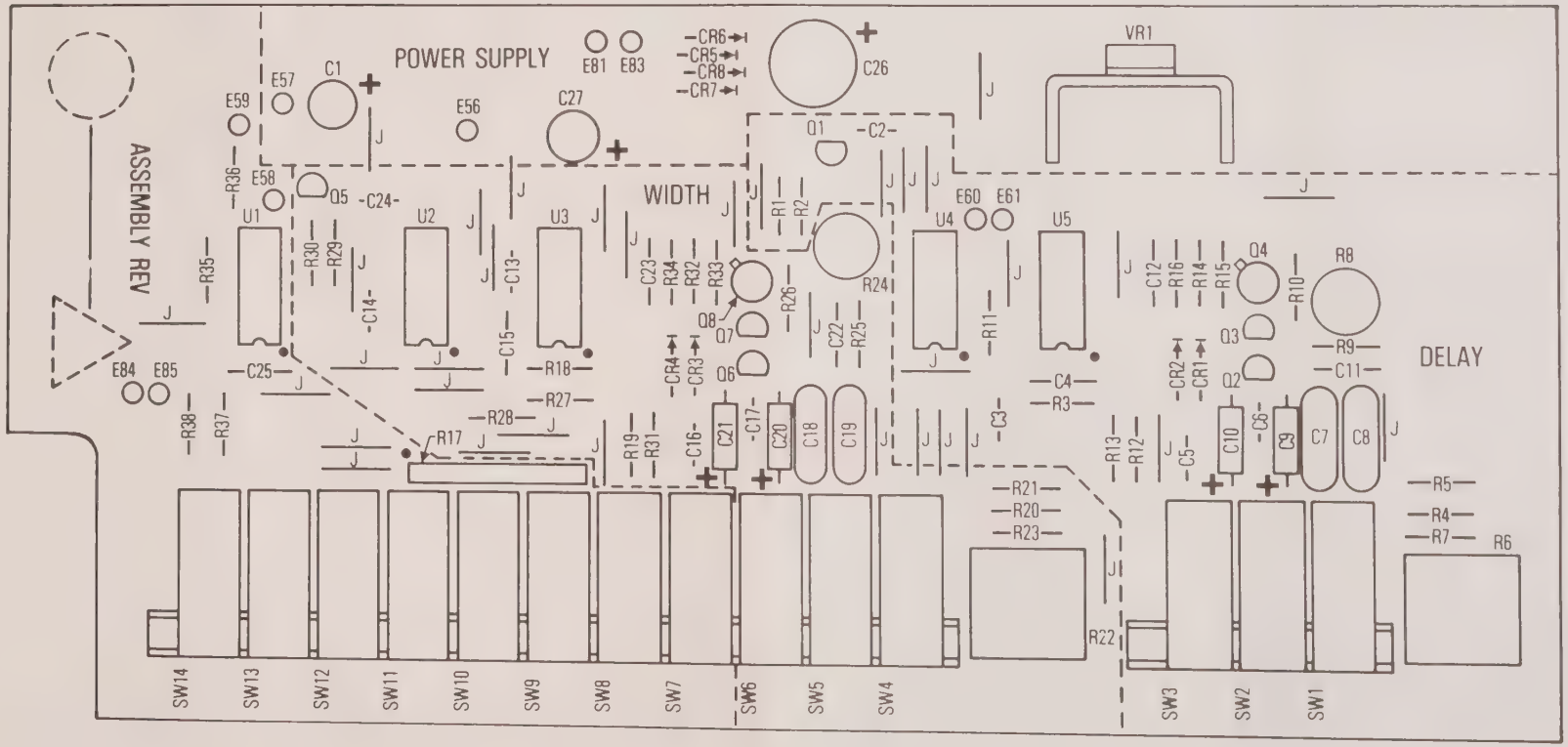

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CA
MATERIAL	APPROVED		TITLE: PULSE BD
FINISH: WAVETEK PROCESS	RELEASE APPROVAL		
	TOLERANCE UNLESS OTHERWISE SPECIFIED: .XXX ±.010 ANGLES ±.05		MODEL NO: 187
	DO NOT SCALE DWG		DWG NO: 1100-00-0843 REV
	SCALE		CODE IDENT: 23338 SHEET 1 OF 1

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REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
NONE	ASSY DRWG PULSE	0101-00-0843	WVTK	0101-00-0843	1
NONE	SCHEMATIC PULSE	0103-00-0843	WVTK	0103-00-0843	1
C16 C3	CAP CER 100PF 1KV	DD-101	CRL	1500-01-0111	2
C11 C12 C15 C22 C23 C25 C4	CAP CER MON .1MF 50V	1802230D50A104Z	VARDN	1500-01-0403	7
C2 C24	CAP CER 15PF 1KV	DD-150	ARCO	1500-01-5011	2
C13 C14 C9	CAP CER 220PF 1KV	DD-221	ARCO	1500-02-2111	3
C17 C6	CAP MICA 100PF 500V	DM15-101J	ARCO	1530-11-0100	2
C27	CAP ELECT 100MF/16V RADIAL LEAD	CRE SERIES 100/16	CAPAR	1500-31-0111	1
C26	CAP ELECT 1000MF 16V RADIAL LEAD	CRE SERIES 1000/16	CAPAR	1530-31-0211	1
C1	CAP ELECT 33MF 25V RADIAL LEAD	CLE SERIES 33/25	CAPAR	1500-33-3002	1
C18 C19 C7 C8	CAP MYLAR .01MF 100V	225P1391WD3	SPRAG	1530-41-0314	4
C10 C20 C21 C5	CAP TANT 1MF 35V	150D105X9035A2	SPRAG	1500-41-0502	4
NONE	PULSE BOARD	1100-00-0843	WVTK	1100-00-0843	1
NONE	SUPPORT TRAP	RAMS-E3-M	PANEC	1200-00-0029	1
NONE	HEATSINK	371	AAVID	2800-11-0016	1
R24 R8	POT TRIM 100K	91AR100K	BECK	4000-11-0402	2

WAVETEK PARTS LIST — TITLE: PCB PULSE BOARD — ASSEMBLY NO. 1100-00-0843 — REV A — PAGE 1

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
R22 R6	POT [illegible] 100K	[illegible]	AB	[illegible]	[illegible]
R11 R27 R28	RES MF 1 6W 1% 100	RN55D-1000F	TRW	[illegible]	3
R37	RES MF 1 6W 1% 1.1K	RN55D-1131F	TRW	[illegible]	[illegible]
R15 R33	RES MF 1 6W 1% 1.21K	RN55D-1211F	TRW	[illegible]	4
R21 R5	RES MF 1 6W 1% 1.5K	RN55D-1521F	TRW	[illegible]	2
R23 R9	RES MF 1 6W 1% 190K	RN55D-1903F	TRW	[illegible]	2
R12 R31	RES MF 1 6W 1% 182	RN55D-1820F	TRW	[illegible]	2
R16 R34	RES MF 1 6W 1% 19.6K	RN55D-1962F	TRW	[illegible]	2
R18 R3	RES MF 1 6W 1% 301	RN55D-3010F	TRW	[illegible]	2
R14 R32	RES MF 1 6W 1% 30.1K	RN55D-3012F	TRW	[illegible]	2
R20 R7	RES MF 1 6W 1% 33.2K	RN55D-3322F	TRW	[illegible]	2
R13 R19	RES MF 1 6W 1% 33.2	RN55D-33R2F	TRW	[illegible]	2
[illegible]	RES MF 1 6W 1% 499	RN55E-4990F	TRW	[illegible]	[illegible]
R1 R29 R30 R4	RES MF 1 6W 1% 4.99K	RN55D-4991F	[illegible]	[illegible]	[illegible]
R35	RES MF [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
R38	RES MF 1 6W 1% 7.5K	[illegible]	[illegible]	[illegible]	[illegible]
R36	RES MF 1 6W 1% 71.5	RN60E-71R5F	TRW	[illegible]	1

WAVETEK PARTS LIST — TITLE: PCB PULSE BOARD — ASSEMBLY NO. 1100-00-0843 — REV A — PAGE 2

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
R17	RES MOD VE	43104-101-682	BOURN	[illegible]	1
R5 R6 CR7 CR8	DIODE	5082-2	SEMT	[illegible]	4
R1 CR3	DIODE	FD-777	FAIR	[illegible]	2
R2 R4	DIODE	FD-6666	FAIR	[illegible]	2
[illegible]	TRANS	2N3642	FAIR	[illegible]	2
Q2 Q3 Q5 Q7	TRANS	2N3904	FAIR	[illegible]	4
Q1 Q6	TRANS	MPS-2369	FAIR	[illegible]	2
NONE	SWITCH ASSY	3103-00-0034	WVTK	3103-00-0034	1
NONE	SWITCH ASSY PB	3103-00-0040	WVTK	3103-00-0040	1
U5	IC	74800	TI	[illegible]	1
U7	IC	74802	SIG	[illegible]	1
U1 U2 U4	IC	74LS42	TI	[illegible]	3
VR1	VOLTAGE REGULATOR	7805KC	FAIR	[illegible]	1

WAVETEK PARTS LIST — TITLE: PCB PULSE BOARD — ASSEMBLY NO. 1100-00-0843 — REV A — PAGE [illegible]

REMOVE ALL BURRS AND BREAK SHARP EDGES
MATERIAL
FINISH WAVETEK PROCESS
DRAWN
PROJENGR
RELEASE APPROV
TOLERANCE UNLESS OTHERWISE SPECIFIED: XX = .010 ANGLES = 1 XX = .030
DO NOT SCALE DWG
SCALE
DATE

WAVETEK

TITLE: PARTS LIST PULSE BOARD

MODEL NO. 187 | DWG NO. 1100-00-0843 | REV A | SHEET | OF

CODE IDENT NO. 23338

NOTE UNLESS OTHERWISE SPECIFIED

BISHOP GRAPHICS/ACCUPRESS REORDER NO. A-3884

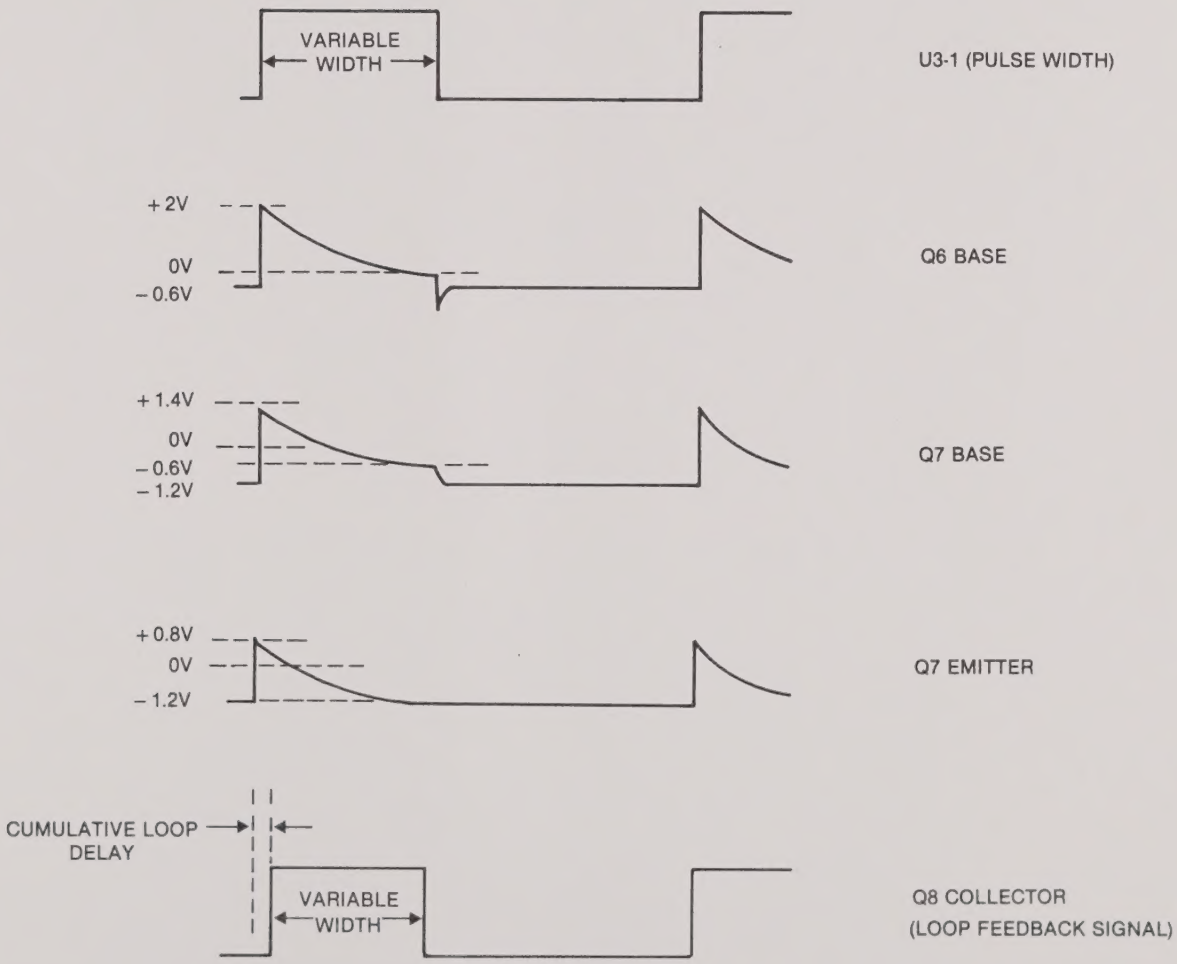
APPENDIX A

SQUARE SHAPER CONTROL VOLTAGES (MAIN BOARD)

	CR31 Cathode	CR30 Anode
	+15V	−3.4V
	+15V	+2.4V
	−2.5V	−3.4V
	−2.5V	+2.5V
	−2.5V	+2.5V
	−2.5V	+4.3V
	−2.5V	+4.3V

APPENDIX B

WIDTH ONE-SHOT WAVEFORMS (BOTH ONE-SHOTS IDENTICAL)



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